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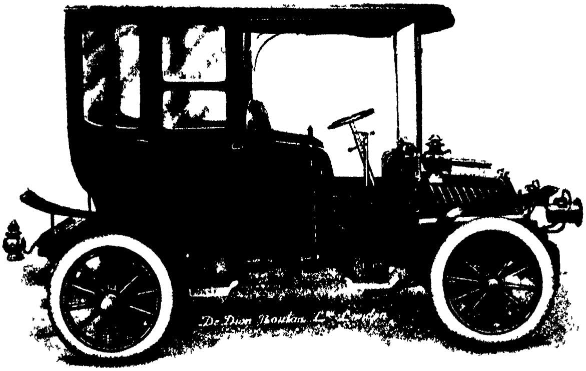
De Dion-Bouton

Motor Cars.



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15 h.p., 24 h.p. ... Four cylinders.

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De Dion-Bouton

Motor Carriages

THEIR MECHANISM AND HOW TO DRIVE THEM.

EDITED BY

R. J. MECREDY

(Editor, The Motor News).

THIRD EDITION.

PUBLISHERS:
MECREDY, PERCY & CO., Ltd., Proprietors, The Motor News,
34 LOWER ABBEY STREET, DUBLIN.

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PREFACE TO THE THIRD EDITION.

The assured success and popularity of the De Dion Cars all over the world, and the fact that new models have recently been added to the list of the Company's productions, have called for a new edition of the Booklet. This, besides dealing with the new 4 cylinder cars, embraces illustrated particulars of the salient features of the various other models. The descriptive matter and points connected with the method of adjusting the gear have also been largely re-written, and amplified where required.

Every effort has been made to treat the subject as lucidly as possible, and in such terms as will be intelligible to the novice motorist. This is a feature which should be borne in mind by critics and the more skilled users of De Dion cars, and, at the same time, should tend to disabuse the mind of the beginner that a De Dion car is a complicated machine, or requires much skill in the handling. That such is not the fact the very popularity of the De Dion cars itself proves.

Furthermore, the chapters on the "Care of the Car" and "Repairs and Adjustments,' have been purposely made almost discursive, so as to cover every possible, or likely phase of derangement. Many of the points touched upon—trivial as they may seem—have been suggested by owners, who, regarding them as novel experiences, have kindly co-operated in presenting them for the reader's benefit.

The De Dion cars may be briefly summarised in three categories—the simple single cylinder machine, the two cylinder, and the four cylinder models. In the main the one is supplementary of the other, so that the beginner who graduates on the first, will readily grasp the even greater ease of handling the largest of the trio. We would, however, add that should any of the De Dionist readers of the Booklet be in trouble at any time, or require further information on any point we shall be pleased to place our experience at his disposal on receipt of full details.

Finally it remains to be said that replacements may be readily procured from the sole British agents on short notice, usually by return post. The parts are all fully standardised, and every item in the car is made in one factory, so that it may be said, in truth, that the De Dion is essentially a "one firm" production from start to finish.

Should the reader experience any difficulty in understanding the exact meaning of any of the technical terms used in this booklet, he will find them fully explained in the "Encyclopædia of Motoring," price, post free, 7s. 10d., which can be had from the office of the "Motor News," 34, Lower Abbey Street, Dublin, or from Messrs. Iliffe, Sons and Co., Coventry and London.

We beg to express our indebtedness to the "Automotor Journal" for permission to use some of the illustrations of the later De Dion features, and a portion of the technical description of the carburetter which appeared in the columns of that excellent journal.

R. J. MECREDY.

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De Dion Bouton Motor Carriages.

CHAPTER I.

The Internal Combustion Engine.

THE following brief explanation of the working of a petrol motor, or, as it is technically called, the internal combustion engine, will be of interest to the novice motorist. The propelling agency is obtained by the sudden expansion of a rapidly ignited mixture of gas and air, rendered highly explosive by compression, but which without the latter condition would have but a very restricted energy. The gas is self-generated from a liquid distillation of petroleum—called shortly, petrol, which, being a light spirit, freely gives off a vapour at a comparatively low temperature; and has most of the properties of a highly volatile spirit. This firing, or lighting, of the compressed gas takes place in a receptacle called the combustion chamber, and the force is exerted on the top of the piston, the purpose of which is described in the diagrams Figs. 1 to 4, under their respective headings. The method of firing the mixture is by an electric spark which is caused to occur, within certain limits, and by the variation of which the propulsive effect of the firing is intensified or lessened—that is to say, the resultant power is largely determined. This is called advancing or retarding the ignition timing.

The Otto or Standard Gas Engine System.

Almost all petrol motors are arranged on the four-cycle system, usually allied with the name of Dr. Otto. This is so called from the fact that the piston makes four distinct reciprocating motions (two forward and two in the reverse direction) as a result of each firing impulse, and each one of which forms part of the work or function of the other, so that while it is a fact that there is only one power or impulse stroke, each of the three following ones is, as it were, preparatory to the next impulse one. These are described as:—(1) the suction; (2) compression; (3) firing; and (4) cleansing or exhaust strokes; the combined four movements necessitating a double rotation of the crank shaft per impulse.

Before proceeding to describe the method of the engine's working, it will be well to note the features of the moving parts.

The Engine and Valves.

The engine illustrated in the four following diagrams, though externally differing from the type used on cars has identically the same moving parts, as regards the main features. These comprise:—I, the cylinder; K, the piston, which is made a sliding fit in the cylinder; I, the piston rings to ensure that the piston is gas tight and prevent leakage of the pressure, and therefore loss of power; M, the connecting rod, by which the power is transmitted to the crank shaft; N, the gudgeon pin, which couples one end of the connecting rod M to the piston (K); O, the crank pin attached to the crank shaft or disc which attaches the other end of the rod (M) to P, the crank shaft, which is rotated by the up and down or reciprocating movement of the piston and connecting rod. From the outer end of this shaft the power is transmitted to the gear wheels and thence to the road wheels—a medium called the clutch being used to transmit the power from the motor to the other mechanism.

Inside the crank case, or box chamber, covering the crank shaft is a pair of small gear wheels, to the larger of which is attached a spindle. This latter controls two important movements, one the opening and closing of the exhaust valve C, and the other the mechanical means for ensuring the firing of the gas at the proper time. The smaller of the two wheels is fitted on the engine shaft, and revolves at twice the speed of the larger, the reason being that the exhaust valve is raised and lowered only once in the two revolutions of the crank shaft. The method employed to lift this valve is a cam, or short arm, which on being rotated pushes up the valve, the latter closing again by the recoil action of the spiral spring (D). The rod and cam will be seen at E and F. A is the induction valve, to which a pipe from the carburetter (where the gaseous mixture is formed) is led, and this valve is held on its seat by a spring B until the suction of the engine overcomes the resistance of the spring. C is the exhaust valve, which is held in position on its seating by the spring D until the operation of cam F pushes the valve upwards, and holds it open sufficiently long to enable the spent gases to escape. How the cycle of operations occurs will be made clear by the accompanying diagram.

The Suction Stroke.

The dotted line—S—represents the highest point

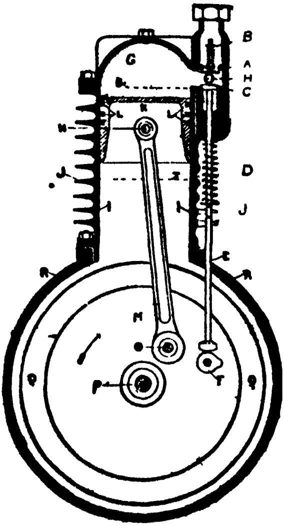


FIG. 1
THE SUCTION STROKE.

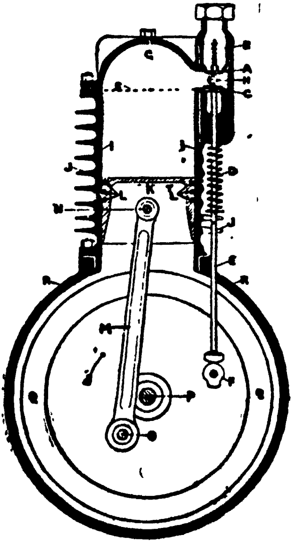


FIG. 2.
THE COMPRESSION STROKE.

touched by the piston when the crank pin—O—is on the dead centre—*i.e.*, occupies a directly vertical position to the centre of the cylinder and the crank shaft. The cavity (G) is termed the combustion chamber, because it is there that the gas is ignited, the expansion of which gives the propulsive force to the piston. Starting, however, from the position of rest, the combustion chamber G is empty, and before a propulsive effort can be obtained, not only must it be filled with gas, but this gas must be compressed. To attain that end the first movement of the piston necessary to draw in the gas for the explosion stroke is obtained by operating with the hand a cranked handle attached to the end of the motor shaft, and this is termed the suction stroke.

Upon operating the handle, the piston K will descend the cylinder in the direction shown by the arrow. The effect of this will be to produce a vacuum between the piston and the combustion chamber. The displacement of air below the atmospheric line—14.9 lbs. pressure to the square inch—plus the degree of vacuum effected will cause the resistance of the small spring B to be overcome, and the valve A will be moved from its seating. As long as this suction influence lasts the valve will be held open, and the gaseous mixture sucked through from the carburetter—to be described later—into the combustion chamber. As soon as the piston has descended a certain distance the valve will again be seated by the recoil action of the spring, as the combustion chamber will have then become filled with gas.

The Compression Stroke.

In Fig. 2 the crank has already passed the bottom dead centre, and the piston has begun to ascend the cylinder. As it does so the volume of gas becomes compressed, until by the time it has reached its farthest point of travel the compression pressure may be as much as 70 to 90 lbs. to the square inch. At that stage the gas is ready for igniting.

The Firing or Power Stroke.

The compressed gas is now automatically fired by an electric spark—the mechanism for which will be described later—and its sudden expansion imparts a species of hammer-like thrusts on the piston, causing it to descend and rotate the crank shaft. From this point the engine becomes self-propelling, and one of the effects of the initial power impulse is to cause a part of the power to be stored up—figuratively speaking---in the flywheel, and so provides for the intervening strokes of the piston until the next impulse can be given to the crank shaft.

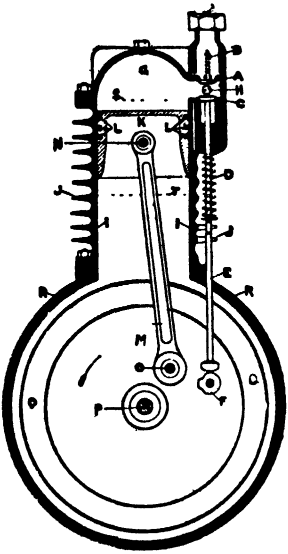


FIG. 3
THE FIRING STROKE.

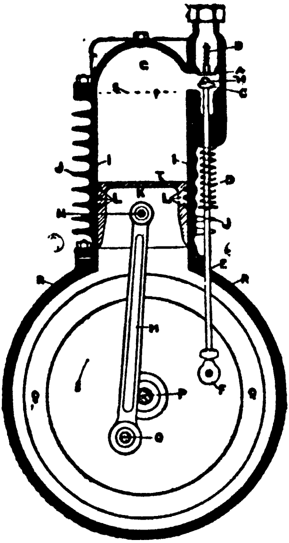


FIG. 4
THE EXHAUST STROKE.

The Exhaust or Scavenging Stroke.

As the piston reaches the end of its descent, the cam, or short arm mechanism, previously referred to, comes automatically into effect, causing the exhaust valve C to be lifted quickly, and holds it open until the piston has reached the top of the cylinder. This ensures the cleansing of the cylinder from the burnt gases. By the time the crank is again on the "dead centre" the exhaust valve will have been returned to its seat, and the four cycles of operation will have been completed.* The piston will again descend owing to the impetus of the fly-wheel, and the same series of cycles will be re-commenced.

The Carburetter.

The carburetter may be termed a species of gas generator, in which a small portion of combustible mixture is automatically generated and passed on to the combustion head. In the "spray," or modern form, it consists of two chambers, one of which contains a constant level of petrol spirit, automatically fed by the action of a floating bulb, which itself operates a needle valve as the spirit is being drawn off to the other chamber on the suction stroke of the engine; and the other, the carburetting vessel, whence the necessary quantity of air is similarly drawn in and mixes with the globules of spirit which are simultaneously caused to pass through a sprayer or jet, as the case may be, from the constant level chamber. By varying the quantity of air admitted to the mixing chamber the strength of the volume is increased or lessened, and a greater or lesser degree of power is available, for the control of which suitable means are provided.

The Method of Igniting the Gas.

This is effected by the passing of an electric spark, so ordered as to be variable in time, but not in strength. The automatic mechanism governing this is partly attached to the spindle on which the cam F is mounted. and at the desired moment an electrical contact is made, *i.e.*, the circuit is completed and the current flows from a battery to a transformer, or coil, where it is re-energised to many thousand times its first strength. As long as the circuit continues the current is flowing, hence it is necessary, both for the economical use of the current and the proper working of the coil, to make as intermittent a connection as possible, but what is more important, to get a sharp rupture or sudden cutting of the circuit. The effect of the rapid breakage is to cause a high tension current to be passed across the points of a plug screwed into the combustion chamber, and the resultant spark or flash ignites the gas. By means of a species of semi-rotating mechanism the actual time or moment for the above to take place may be varied at the will of the driver, but this will be incidentally dealt with in the description of the contact breaker fitted to the De Dion Cars.

CHAPTER II.

THE FEATURES OF THE DE DION MOTOR.

No. 1—The Single Cylinder Engine.

THE single cylinder motor is fitted to the 6, 8, and 9 h.p. models, and its features are common to both. A study of the diagram—Fig. 5—will make the details generally clear.

I. This is the outlet through which the water escapes on its way to the tank and radiators, having performed its function of cooling the cylinder. The ingress pipe is at J. The blank space on which the letter J stands represents the water jacket which encircles the cylinder.

D. This is the compression tap, opening into the combustion chamber. It is not now fitted, but instead a valve depressor is placed over B.

B. This is the induction or inlet valve, held in position by a spring. It is sucked open by the action of the descending piston, which at the same time draws in the charge of explosive mixture to the combustion chamber.

E. This is the aperture opening into the combustion chamber with screw shown, into which the sparking plug which ignites the mixture is screwed.

C is the exhaust pipe through which the products of combustion escape into the silencer. The exhaust valve is at the head of this pipe directly under the inlet valve, and is normally held to its seating by the spring F. The mechanism which opens the exhaust valve will be described later. In all De Dion engines a device is fitted by operating which the lift of the exhaust valve can be limited so as to prevent all the spent gases from escaping. A reduced charge is consequently taken into the combustion chamber, and the engine governed by this means. This exhaust valve-regulator is described farther on in this chapter.

L. This is the piston. The three blank spaces shown are for the piston rings (which are shown in place in Fig. 6). They are employed to ensure a gas tight joint

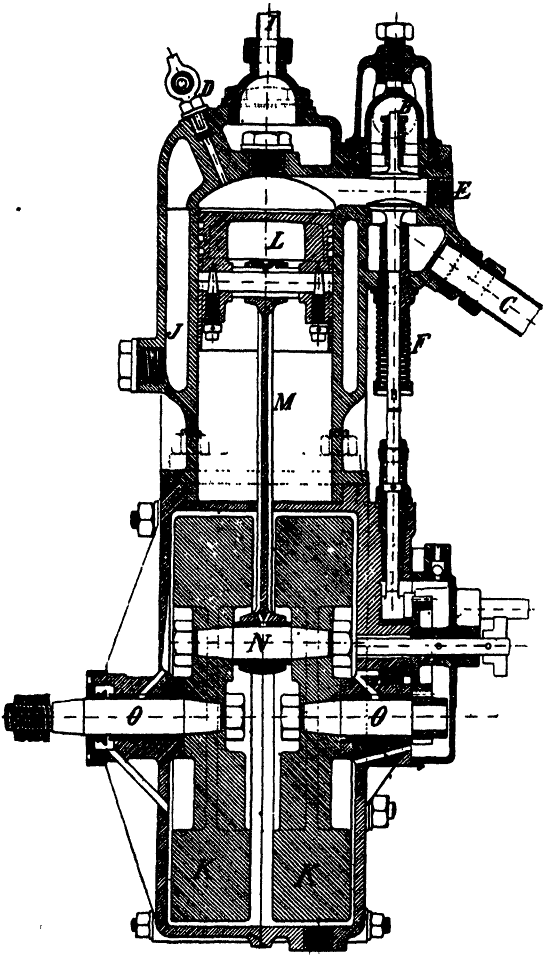


Fig. 5—Section of De Dion Bouton Water-cooled Engine

A, Oil outlet; B, Inlet valve; C, Exhaust pipe with exhaust valve at upper end D, Compression tap (this is no longer fitted); E, Sparking plug hole; F, Spring for exhaust valve; I, Water outlet; J, Water inlet; KK, Fly wheels; L, Piston; M Connecting rod; N, Crank Pin connecting fly wheels; OO, Motor shafts.

between the cylinder and the moving piston. The material used for both piston and rings is cast iron. The rings are made slightly larger in diameter than the piston, are split as shown, and require an amount of pressure to contract them sufficiently to fit in the cylinder. It is necessary, therefore, that only just sufficient space at the ends of the rings should exist to ensure their being gas-tight when in the cylinder. The method of securing the gudgeon pin in the piston is by two taper pins which screw into bosses cast inside the piston, and are so fixed as to prevent them working loose.

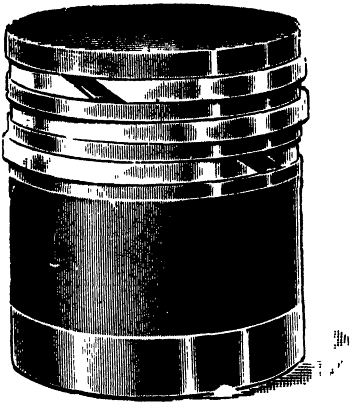


FIG. 6 - THE PISTON.

M. is the connecting rod which transmits the motion of the piston to the crank shaft. It is coupled to the piston at one end by a gudgeon pin, which will be noticed in Fig. 5—transversely below the letter L.

N. The crank pin on which the other end of the connecting rod works.

KK. The flywheels which form one with the crank pin. Their object is to maintain the speed of the engine in the interval between the firing impulses.

OO. The motor or crank shaft. The left-hand section is connected with the gear shaft by means of a coupling, and by it the power of the motor is transmitted to the gearing, and thus to the live back axle. The right-half section operates what is commonly known as the two-to-one shaft, because it only revolves once to every two revolutions of the engine shaft (see B, Fig. 8). It is just above O, and parallel to it.

A. This is an aperture at the bottom of the base chamber which is fitted with a tap not shown in the engraving. Its object is to permit the waste oil to escape.

The Exhaust Valve and Timing Gear.

The function of the mechanism shown in the engraving —Fig. 7—is to raise the exhaust valve at that particular point in the travel of the piston which will admit of the escape of the burnt or exhaust gas to the best

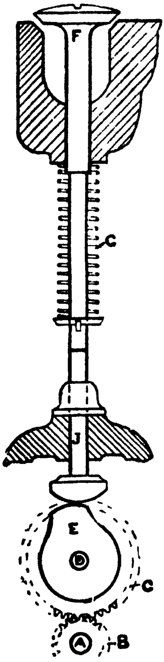


FIG. 7—THE EXHAUST VALVE AND TIMING GEAR.

A, Motor shaft; B, Pinion on same; D, Two-to-one shaft; C, Pinion on same; E, Cam attached to pinion C; J, Plunger; F, Valve stem; G, Spring; H, Valve.

advantage. If this occurs too early the exploded charge will escape past the valve before all its effective power has been expended; if too late, then the piston will be working against a back pressure. In either case the power will be greatly reduced.

The small gear wheel B is fixed to the crank shaft of the engine A. This wheel engages with another wheel C, exactly double the size, so that this wheel only revolves once for every two revolutions of the crank shaft. In the solid with this wheel C is mounted a cam E. This cam raises the plunger J, which in turn acts on the valve stem F, and so lifts the valve H from it seating, and allows the burnt gas to escape. Spring C holds the exhaust valve to its seating when the cam ceases to operate J. Fig. 7 shows the general principle of the valve lifting mechanism, but Fig. 8 illustrates its application to the De Dion.

In a correctly adjusted De Dion motor:—(1) The exhaust valve should commence to rise when the piston is 7 or 8 m/m (about 5/16 ins.) from the bottom of the explosion stroke. (2) The exhaust valve should rest on its seating when the piston is about 3/32 inch from the top on the exhaust stroke.

At the end of the shaft D (commonly called the half-speed shaft) which carries the gear wheel C is a cam (not shown in Fig. 7), the function of which is to time the moment of ignition. Its operation is explained further on. If the gear has been meshed correctly at the outset it is easy to mark any two engaging teeth to simplify assembling. If, however, the timing is wrong, it will have to be re-set, which will require much care and the knowledge of what to do.

The De Dion Exhaust Valve Regulator

This contrivance (Fig. 8) really acts as a speed governor, and is fitted, as shown, to all the De Dion engines. By retaining, with the aid of a variable mechanism, a portion of the exhaust gases a full charge of fresh gas is prevented from being drawn in at the inlet valve, and at the same time the volume of compression is preserved.

When the valve is partly closed, the burnt gas after each explosion has less time to escape, and a reduced opening through which to escape: some, therefore, remains in the cylinder, and takes up a certain amount of space. It thereby prevents the fresh gas being drawn in to as great an extent as if the cylinder had been practically cleared of burnt gas during the exhaust stroke. An important feature in the due balancing of the engine when running is therefore retained, and the motor may be run steadily at a speed considerably below the normal.

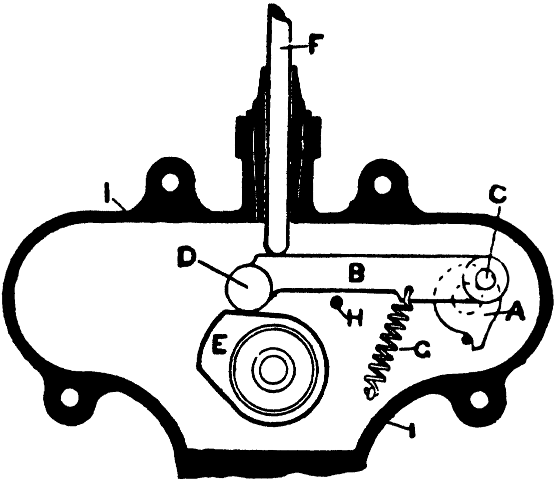


FIG. 8—THE EXHAUST VALVE REGULATOR.

The cam E, which lifts the exhaust valve acts on the end D of a rod B, pivoted eccentrically on to a rocker A, which is moved by a lever controlled by the pedal or the hand lever.

Normally the rocker A is so placed that the rod B is at its highest point, and thus at each revolution of the cam E the exhaust valve is opened to its fullest.

If the rocker A be revolved from right to left, the rod B is pushed forward so that cam E reaches D at a later point in its revolution, therefore a lesser lift is given to the plunger F. (The illustration shows the cam E leaving end of rod B.) According to the amount of motion given to A, the lift of the exhaust valve is regulated. H is a stop on which rod B rests when at its lowest. G is a spring which maintains B in position.

The control of the exhaust closer is by means of

(*a*) A pedal.

(*b*) A small hand lever working over a quadrant mounted by the steering column (except on some two-cylinder cars). Pressing the pedal down slides forward the rocker A, and reduces the lift of the plunger F. If the pedal be still further depressed it will operate a brake on a drum attached to one of the gear shafts. The working of the latter will be explained later.

The De Dion Water Pump.

The pump used on all De Dion cars is the same in style, only differing in size to suit the required greater capacity for a larger engine, and to ensure a full and constant

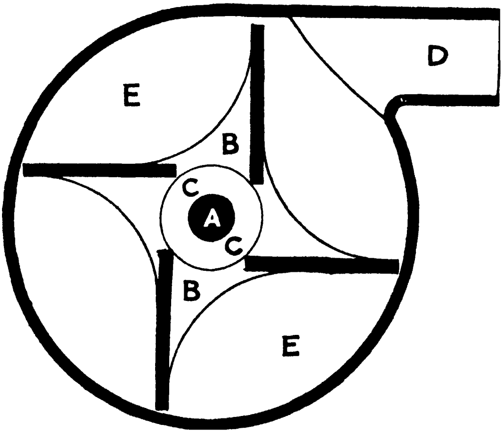


FIG. 9—THE DE DION PUMP.

circulation of the water round the cylinder jackets and the combustion chambers. The displacement of water is effected centrifugally, and the pump is therefore styled a centrifugal acting one. The diagram explains its construction, where A is the spindle on which are mounted the four vanes or blades (B). The spindle, which at its outer end is coupled to the half-speed shaft of the engine, runs in a pair of bearings. The one is formed in the cover of the casing, and is lubricated by the surrounding water; the other, through which the shaft enters, is in the casing. The bearing in order that it may be water-tight, has its extreme end fashioned as a "gland neck." This consists of a circular recess, surrounding the shaft, being concentric with it, into which "packing" is introduced. A circular flanged nut is slipped into the box and is tightened down putting pressure on to the packing, compressing it, and forcing it into intimate contact with the shaft. thus effectually preventing any escape of water. The nut for tightening the gland is screwed to the outside of the casing extension, and is held by means of a spiral spring between it and the side or face of the portion of the case containing the fan. A few hints on the method of packing the gland will be found in Chapter IV.

EE. is the casing surrounding the fan, into which the water is drawn and thence ejected. The water from the radiators is led to the centre of the fan marked C, and with the fan rotating at a high rate of speed, the water is ejected through the pipe D, and passes to the water jacket. The route traversed by the water in all the later models is thus:—

From bottom of water tank to bottom of radiator.
Top of radiator to pump.
Pump to bottom of water jacket
Top of water jacket to tank.

No. 2—The Twin Cylinder Engine.

Fig. 10 is an external view of the engine, and Figs. 11 and 12 the same in vertical section longitudinally and transversely. A study of these diagrams, aided by the subjoined keys to the various parts, will enable the reader to understand the mechanism, and its action. The cranks are set at 180 degrees, so that there are two explosions in sequence in one revolution, and none in the next The cylinders are cast together, with the water jacket common to both. The latter is fitted with detachable faced covers, E1 and E2 (Fig. 11). The same type suction-lifted inlet valve employed on the single cylinder engine is used, and the exhaust valve regulator is operated in the same way. The chief feature of the twin cylinder engines is the method of lubrication. In most motors, as in the single cylinder De Dion, the splash from the crank is relied upon to lubricate all the parts, but in the two cylinder model, a forced system is employed, which renders lubrication both certain and economical. In Fig. 12, ZZ is an oil pump, driven by the vertical shaft Y, rotated by a worm on the half time shaft W of the motor. On the side of the cylinders opposite the valve chambers there is an oil reservoir, into which three pipes are fixed, one reaching almost to the top of the reservoir, and the other two only just entering at the bottom. From these, two copper pipes lead to the crank shaft bearings, the brasses of which are so grooved as to provide a free pass

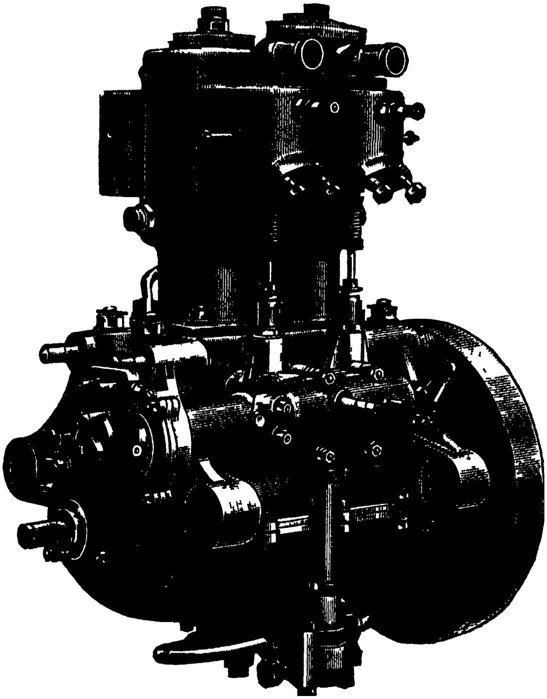


FIG. 10— 10 AND 12 H.P TWO-CYLINDER DE DION ENGINES.

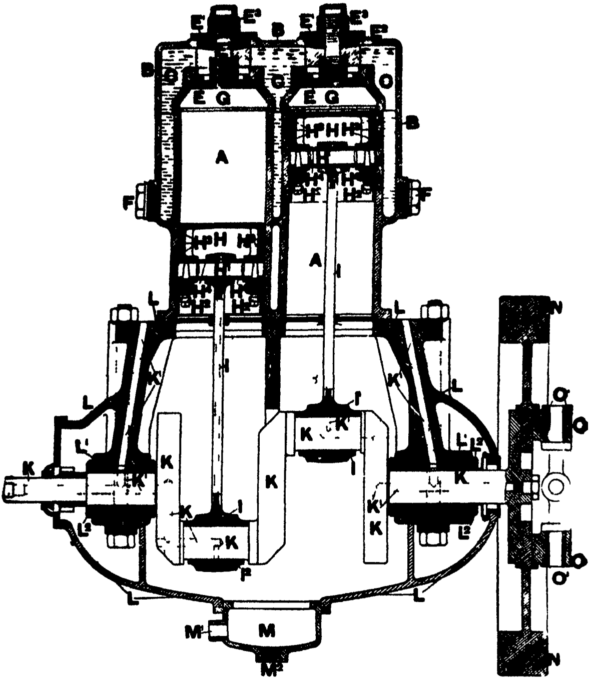


FIG. 11 SECTION OF TWO-CYLINDER DE DION MOTOR (LONGITUDINAL)

AA, cylinders
BBB, water jacket
CCC, water space.
EE, lower cylinder caps.
E1E1, outer cylinder caps
E2E2, studs to cylinder caps.
E3E3, nuts to cylinder caps.
FF, water jacket plugs.
F1, water inlet.
GG, cylinder compression spaces.
HH, pistons.
H1H1, gudgeon pins.
H2H2, set screws for holding gudgeon pins.
H3H3, piston rings
H4H4, phosphor bronze bush.
II, connecting rods.
I1I1, big ends.
I2I2, big end bushes.
KKKK, forged steel crankshaft
K1K1, oil leads.
LLLL, aluminium crank chamber.
L1L1, bearings formed in crank chamber.
L2L2L2L2, phosphor bronze bushes for crankshaft bearings.
M, oil well of crank chamber.
M1, junction for suction pipe to oil pump.
M2, washout plug.
NN, flywheel.
OO, engine shaft, half of the universal joint

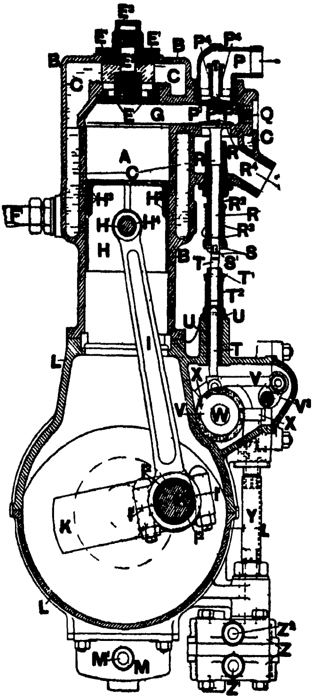


FIG 12—SECTION OF TWO CYLINDER DE DION MOTOR (TRANSVERSE)

O_1O_1, bushes to universal joint.
P, induction valve dome
P_1, induction valve
P_2, induction valve spindle,
P_3P_3, induction valve spindle pipe.
P_4P_4, induction valve spring
Q, sparking plug orifice
R, exhaust valve
R_1R_1, exhaust valve spindle
R_2, exhaust valve spindle
R_3, exhaust valve spring
S, exhaust valve spring cap.
S_1, cotter securing same
T, exhaust valve striking rod.
T_1 and T_2, cap and spring to same
UU, bushed guide to exhaust striking rod
V exhaust valve striking lever varying lift of exhaust valve
V_1, exhaust cam
V_3, link movement for varying lift of exhaust valve
W, half-time shaft
X, worm wheel on half-time shaft driving perpendicular pump shaft
X_1, worm wheel on pump-shaft.
Y, perpendicular pump shaft
ZZ, rotary oil pump
Z_1, oil suction pipe
Z_2, oil delivery

age for the oil all round the shaft. The crank shaft, the crank throw (as the metal between the shaft and crank pin is technically called) and the crank pins themselves are all bored out, and radial passages communicate with the outside of the bearing surfaces, the mouths of these conduits rotating within the groove formed in the brass bushes

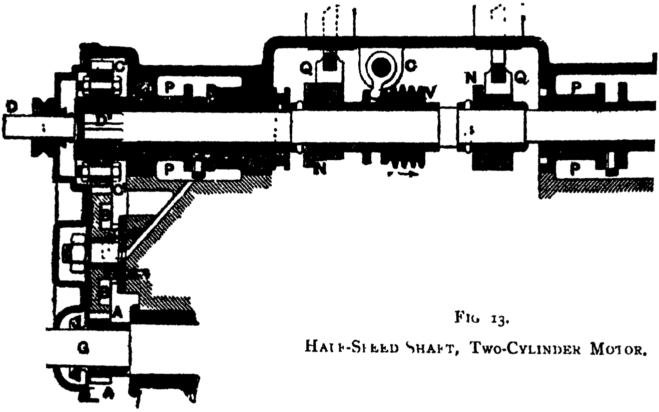
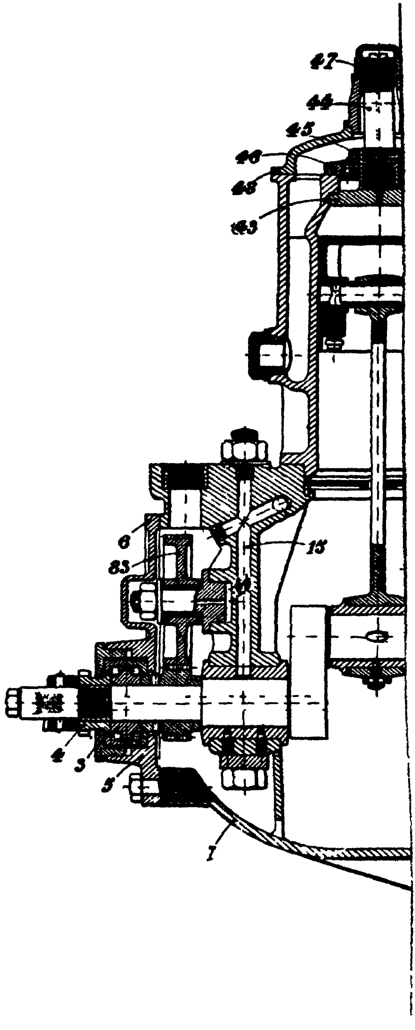


Fig 13.
Half-Speed Shaft, Two-Cylinder Motor.

A, pinion driving half-speed gear shaft.
B intermediate pinion.
C, lever to move sleeve carrying worm for driving pump and exhaust valve cams.
C_1, pinion on half time shaft.
D, extension of half-time shaft to receive contact breaker cam.
D_1, Cap.
D_2, half speed shaft.
G, crank shaft.
NN, extra cams to slightly reduce con pression to facilitate starting.
P, oil wells for ring lubrication of hal speed shaft bearings.
Q, part of exhaust valve regulat under exhaust striking rods. (Se V. fig. 2).
V, worm engaging pinion on pump shaf

about the shaft, so that there is a perfectly clear passag for the oil into the centre of the shaft, up through th throws (assisted by the pump's action) and along to th centre of the crank pins, where another radial hole give access to the connecting rod bearings K. In Fig. 11 the oil leads are dotted in. and are marked K_1,K_1,K_1,K_1 Thus, if we suppose the oil tank affixed to the side of th cylinders to be full of oil, this oil will tend to flow dow



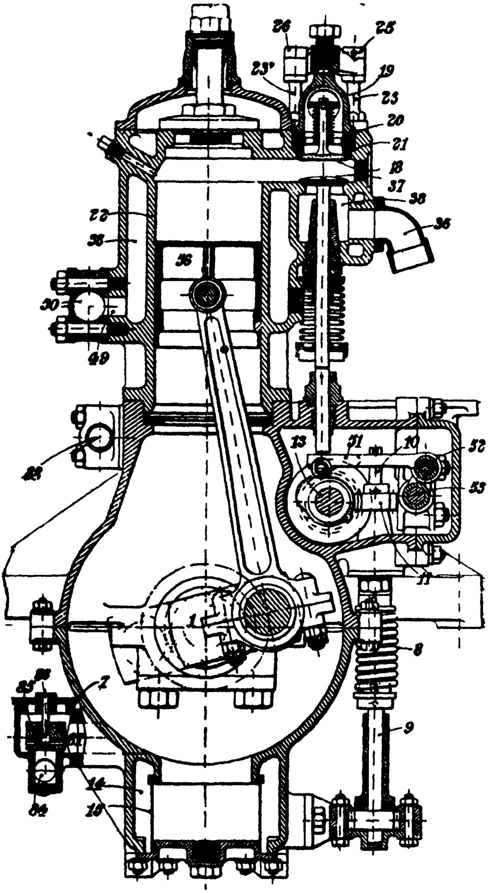
1—Crank shaft; 2—Coupling flange
valve motion gear; 7—Oil chamber f
bearings: 19—Dome or inlet valve
pipes; 32, 33, 34, 35—Coupling deta
47—Details of combustion head pl
same, 44 stud bolt); 48—Water jack

the pipes to the bearings, round the grooves, part of it being carried up to the crank pins; but all of it being eventually returned to the well M in the bottom of the crank case, whence it is drawn by the pump and returned to the tank at high level. In reality the pump is only employed to return the oil to the tank, it again finding its way to the crank chamber by gravity, whence it is circulated through the passages and oil channels by the action of the revolving cranks.

Provision is also made whereby the compression can be partially reduced to facilitate ease in starting. This is done by sliding the half time shaft, so that a pair of extra cams, N.N. in Fig. 13, come beneath the exhaust lifting mechanism. The exhaust cams, the extra cams N.N., and the worm V which drives the vertical oil pump shaft, are all in connection, and move together, such movement in a lateral direction being obtained from the lever C, which engages with a groove cut in the sleeve on which the worm and cams are formed. This movement makes no difference to the worm V driving its pinion on the pump shaft, as the thread of the worm acts simply as a toothed rack. The care that has been taken to ensure perfect lubrication is instanced again by the fact that even the cam shaft bearings have oil wells and ring lubrication. Magneto ignition is now fitted to this engine.

No. 3—The Four Cylinder Engine.

The four cylinder model is largely a duplicate of the preceding type, but has some features peculiar to itself. These include a centrifugally acting governor, placed at the end of the half time shaft, and a special form of electric distributor working in conjunction with a single non-trembling coil. The governor acts on the throttle of the carburetter, though in addition the special De Dion feature —the exhaust valve regulator—is retained. It will be necessary to deal with the engine *in extenso*, but it must be at once said that it is not more complicated, but rather possesses features which, in combination, facilitate control, while the running of this motor, its flexible action, and almost absolute noiselessness, make it a luxury to handle. Magneto ignition is fitted to this model.



FIG, 15.—TRANSVERSE SECTION OF DE DION 4-CYLINDER ENGINE.

1, Crank shaft end. 8 and 9. Spring and spindle for oil pump.
10 and 11, Spindle with pinion on same which meshes with the cam shaft worm.
12 and 13, Worm and cam shaft. 14, Crank base (end view)
18, 19, 20, 21, Inlet valves, dome for ditto, seat and joints for same respectively, cylinder walls.
23, 24, 25, Turned columns for yokes holding down inlet valves, fixed collar-nut, and detachable ditto for same. 36, Exhaust pipe leads.
37, 38, Exhaust valves and outlet. 50, Water feed pipe
51. Intercepting lever fulcrumed at 52, for varying lift of exhaust valves.
52, 53, Crank and horizontal spindle for effecting above purposes 56, Pistons.
84, 85. 86, Details of relief pressure valve for oil circulation, and 87, grove to oil reservoir for oil returned by action of above valve. 88, Oil feed pipe.

[NOTE.—The magneto is not shown in the above illustration.]

The crank shaft (Fig. 14) is carried in five bearings, each supported by an adjustable stay bracket, suspended from the top of the crank chamber. The method of jointing the jacket covers, 43 and 46 (Fig. 14), differs slightly from the previously described patterns. The bolt, 44, is solid with the plate, 43. The latter is a recessed spigot, and beds up to a corresponding recess formed at the top of the cylinder. The plate, 46, also faced, fits on to the top of the cylinder, and both are drawn tight by the nut 45. The top of each water-jacket is fitted with a detachable cap, so that ample facilities are provided for cleansing the interior of the jacket. The cylinders fire in the following order—1, 3, 4, 2, and the pistons 56 (Fig. 15) have a fourth ring fitted near the mouth, with the object of intercepting any excess of lubricating oil from passing the piston heads into the combustion chambers. The valves are identical in arrangement and mode of operation with the single and twin cylinder types, and provision is made for rapid dismantling of the main and branch vapour pipes—32 to 35—by means of swivelling yokes. The illustration—Fig. 16—shows the cam shaft in section, and it will be noted that while retaining the features common to that used on the two cylinder model, there is also added a simple centrifugal governor, which will be better seen in section at Fig. 17. The shaft D (Fig. 16) and the governors are carried in an oil tight case. The cams, D1, are stepped, that is to say, have two profiles, whereby one half the compression is obtained which facilitates ease in starting. The shaft is carried in three bearings, which are held in place by set pins. By withdrawing the latter the shaft may be removed, without disturbing the rest of the engine. The cam shaft D is driven by an intermediate spur-gear wheel (not shown), while at E (Fig. 16) will be noticed a worm, which drives the high tension current distributor (to be dealt with later), and also the oil pump through the spindle (Fig. 15) at a speed reduction by three-fourths of the crank shaft revolutions. Though not exactly integral to the description of this motor as fitted to the De Dion car, it should be pointed out that provision is made at 50 and 88 (Fig. 15) for driving the water pump and commutator from the side of the engine if required. For this purpose the bevel pinion—D9 (Fig. 16)—is fitted to the cam shaft D. The lower diagram at

Fig. 16 shows the weigh or rocking shaft—D4, which is arranged for a sliding movement, as well as a partially rotating one. The object of this is to facilitate the half compression movement of the cams, D1; and this fore and after movement is effected by the lever arm, D5 (Fig. 16, end view diagram), which engages with the collar D6. The spring, D8 (Fig. 16), ensures the shaft returning to the normal or full compression position on the lever arm—D5—being released. The arrangement for operating the exhaust valve closer is on the usual De Dion plan, the details, however, being slightly modified On referring to Fig. 15, the relative positions of the cam shaft—13—and the rocking shaft—53—will be seen. By means of the cranks—53—and the levers—51—the period of opening the exhaust valves may be varied according as the lever is slid forward to meet the cams, or retarded. Reference to Fig 16 shows the position of the crank brackets—D2 and D3—carrying the lever—51 (Fig. 15)

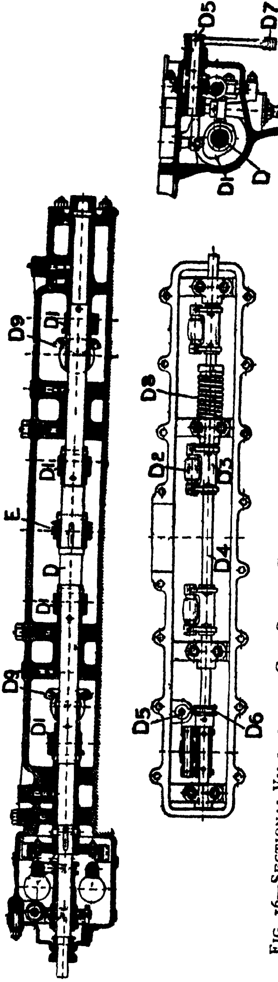


Fig. 16—Sectional Views of the Cam Shaft, D; the Rocking Shaft, D4, and the End Elevation of the Exhaust Valve Regulator

The governor details will be noted at Fig. 17, where C4 shows the method of fixing it to a recess formed on the spur wheel of the cam shaft, and H represents the balls, four in number; H1, the sliding sleeve; H2, the spring for restricting the undue action of the balls, H; H3, a ball bearing for the sleeve H1; H4, a stop-pin to prevent the rotating of H3; and H5, a spindle which carries the forked lever, operated by the sliding movement of the sleeve H1, according to the centrifugal force exerted by the governor. The spindle—H5—which projects outside of the casing, has attached at one end a lever arm, which operates a rod affixed to the throttle lever of the carburetter.

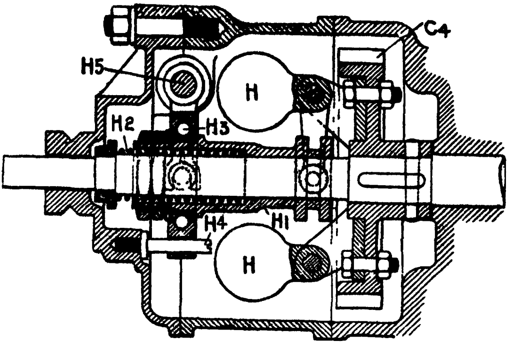


FIG. 17—SECTIONAL VIEW OF THE GOVERNOR

The details of the gear driven oil pump may be seen at Fig. 15, where 8 shows the helical spring attached to the vertical spindle—9--the latter driving the pump, which is placed at the base of the crank chamber. A filter is there formed (Figs. 14 and 15), through which the oil is supplied to the pump, and thence forced through the conduits into the bearings. A relief pressure valve is interposed—the details of which are embraced in Nos. 84-87. The object of this is to prevent too great a pressure of the oil at the bearings. When such obtains the valve is lifted, causing the oil to be returned again to the crank chamber. Suitable provision for cleansing the filter, and draining the base chamber is made, the details of which will be seen at Fig. 14. In the same diagram it will be noticed that the ball thrust bearing is fitted at the front and not at the rear end of the crank shaft, the details of which are comprised in Nos. 3, 4, and 5 (Fig. 14).

THE DE DION CARBURETTER.

The Principle of Action.

Three forms of carburetter are used on the numerous De Dion cars. In principal and main features each is alike, but to prevent confusion each will be separately illustrated and described.

The principle of action is that the petrol is converted from its liquid state into a highly combustible mixture by carrying a current of air over a nozzle or jet orifice, so that a fine spray is formed, which is instantly vaporised. The resulting mixture is then passed to the engine, where it is compressed, fired, and ejected through the exhaust pipe. The explanation of the action may be thus described:—

The suction of the motor sets up more or less perfect vacuum in the induction pipe and the carburetter, and, on the principle that nature abhors a vacuum, air immediately rushes in to fill the void. However, the vacuum also acts upon the nozzle through which the petrol flows, and as a consequence, the petrol is sucked through in a very fine stream, when owing to its fineness and also to meeting the inrushing air, it is instantly converted, first into spray, and then to vapour on its passage towards the engine.

Now it is necessary for the petrol vapour and air to be mixed in certain relative proportions in order that the best explosive effect may be produced, no matter what the speed of the engine may be, but unfortunately the proportions of petrol and air drawn up as the speed of the engine increases and the suction becomes more powerful, do not remain constant, the result of an increase of speed being to suck up a much greater quantity of petrol than necessary, so that the mixture becomes too rich to give effect. Thus in order to get a correct mixture this over-rich gas must be further diluted with air until the correct proportions are again reached. Accordingly if the amount of air rushing past the jet could be so regulated that only a sufficiency of petrol were sucked up in spray form at any, and every speed, to make a perfect mixture with the air admitted through a second and supplementary air inlet, also adjustable, we should have a carburetter of great merit.

Briefly described, the De Dion carburetter is built on the lines of a twin or two-way tap, the air being drawn in completely along one path, or divided into two branch currents. In other words, the manipulation of this tap either causes the whole of the air drawn in through the carburetter to pass the petrol jet, or to divide it in varying amounts, so that a portion passes the jet, and becomes richly charged with petrol vapour, and the rest, as pure air, flows directly into the induction pipe where it mingles with the volume of air which has passed the jet, the two combining to form a correct explosive mixture, or reduces the opening to the carburetter, and nearly cuts off the air altogether. The extremes of position to which this tap can be turned either cause the whole of the air to pass the jet or half the air to pass the jet and the other half to flow straight through and remingle with that which has become charged with petrol by passing the jet, the two flowing onward into the cylinder a completely homogeneous gas, containing air and petrol vapour in the proportions best calculated to give the most powerful result on firing. This twin tap or lantern form of regulator is

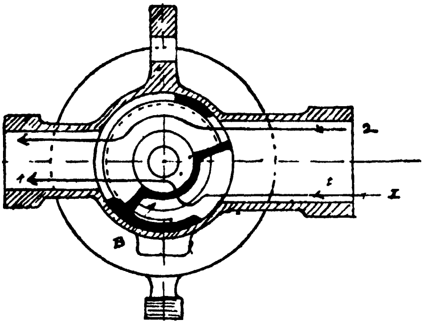


Fig. 18—The De Dion Lantern Type of Mixing Valve.

illustrated at Fig. 18, which gives a fair idea of its construction. The reader must imagine that he is looking down on to the carburetter, and that the dark line represents the lantern sleeve. As here shown, the larger bulk of the air would be following the direction indicated by 1 to the bottom of the carburetter. It would thence pass over the spraying nipple, and the vaporised mixture would pass to the engine along the inlet pipe.

Line 2 (Fig. 18) shows the current of pure air which runs direct into the pipe t1, and there mixes with the other current of petrol-saturated air. It will easily be seen that if the lantern sleeve be revolved a little further from left to right the air inlet pipe t1 will be divided equally, half the air following the line 1 downward round the spray, and half the air going direct into the inlet pipe t1. This is the correct position when the motor is running at its fastest speed.

Thus it follows, as previously described, that an increase of speed on the part of the engine demands that the tap be so opened that less air pass the jet and more pass direct to the engine, whilst a decrease of speed will render a closing of the tap necessary, so that a greater proportion of the induced air will pass the jet; by this means suction on the petrol is kept up to the required amount. The control of the lantern sleeve is by a lever and rod coupled to a short hand lever conveniently placed by the steering wheel column. When this lever is moved as far as it will go, the air opening is equally divided by the shutter, half the air passing over the spray and the other half direct to the motor through pipe t1. When the lever is placed in the central position the size of the air inlet is not reduced, but the knife edge of the shutter moves forward so that all the air is deflected over the spray, none going direct into the pipe t1. If the lever be moved further forward the air inlet is gradually reduced until the farthest position is nearly closed.

THE DE DION CARBURETTER.

Type No. 1 (Early Model).

The model illustrated at Fig. 19 is that used on the 6 h.p. single cylinder De Dion, the obsolete 4½ h.p., and the earlier 8 h.p. cars. The suction never being very great or sustained, it is necessary to ensure that the level of petrol in the jet should be near its orifice, and maintained there to a constant height. To effect this a device known as the float feed is employed, but the De Dion feed device differs from others in that it is so arranged that the jet is in the centre of the float, so that no matter whether the car is running on the level or ascending or descending a hill.

the level in the jet is never altered relatively to the level in the float chamber. This is accomplished by forming the float like a ring, which is balanced outside the spraying chamber. In the illustration it is marked C. It is made of very thin sheet brass, and is perfectly air-tight,

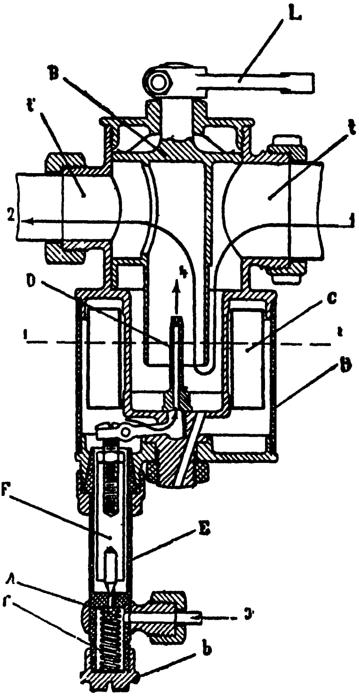


FIG. 19—THE SINGLE CYLINDER CARBURETTER USED ON THE OBSOLETE 4½, THE 6, AND THE EARLIER 8 H.P. MOTORS.—TYPE NO. 1.

so that it will float on petrol. The method by which it keeps the level of the petrol constant is as follows. The lower face of the float rests on the arms of a forked lever, a portion of which can be seen. This lever is pivotted, and at the end opposite the fork the head of a screw is hooked over it. This screw is attached to the combined balance weight and needle, which latter normally closes the petrol supply by coming in contact with its seat. The weight of the screw, and the weighted needle valve just sensitively balance the weight of the float, and when the level of the petrol is correct in the float chamber H, the valve F sits on its seat and prevents any more petrol flowing into the chamber. When, however, the petrol level tends to drop owing to its being drawn into the jet D the float sinks responsively, thus depressing the end of the forked lever in contact with it, and so raises its other end, and so lifts the valve F, permitting more petrol to flow in until the level is again reached, when the supply is cut off once more. The balance of the mechanism is so delicate that the variation in level that takes place is quite inappreciable. The petrol is led in from the tank through the pipe 3, and passes the little gauze cap A, which envelopes the under side of the needle valve seat, being held in position by a spring r. This gauze cap is employed to intercept any dirt which might either prevent the needle valve from reseating or be swept up into the jet and clog it.

The air is drawn into the carburetter through the pipe t, and is divided into the two portions by the regulator valve or lantern, B. part of it passing down and up again past the petrol jet D, and the rest straight through from t, to t1. The plan of the carburetter shown will enable the reader to trace the actual path of the air. The direction line on this diagram marked 1 at its right hand end and 2 at its left, indicates the air current which passes the jet and carries the petrol vapour mingled with it into pipe t1, there to mingle with the pure air drawn in through the other part of pipe t, the relative quantities of which are varied, as already described, by the valve B.

THE DE DION CARBURETTER.

Type No. 2.

The carburetter fitted to the single cylinder and four-cylinder motors, is generally similar to the type previously dealt with, but a grasp of its details will be better obtained by a close study of the diagram Fig. 20. The concentric or annular float J limits the supply of petrol through the agency of the needle valve J3, an adjustable

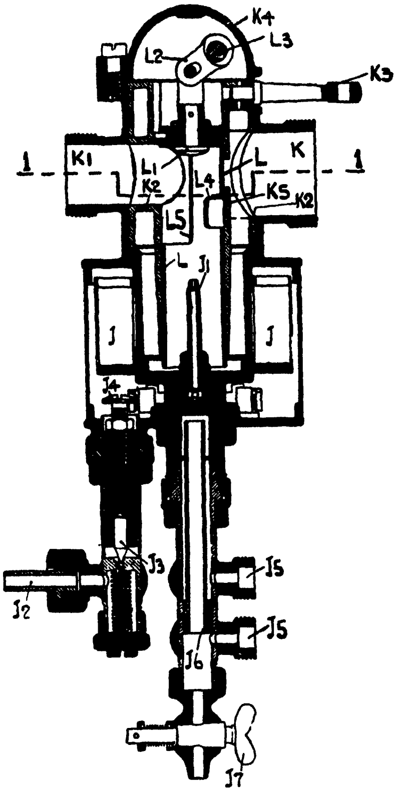


Fig. 20 — Sectional View of Carburetter—Type No. 2.

J, float.
J1, jet.
J2, petrol inlet.
J3, needle valve
J4, adjustable screw for do
J5 J5 water copuling.
J6, inflow tube of water circulation.
J7, drain cock.
K, air intake.
K1, vapour outlet to motor.
K2, casting for throttle valve or sleeve.
K3, lever for do.
K4, dome cap.
L, sliding tube.
L1, pin connecting tube L with L 2.
L2, lever arm attached to L 3.
L3, lever operating tube L
L4, air post in tube L.
L5, main or mixture outlet in tube L.

set screw—J4—engaging with a pair of light levers, these latter being placed below the float, which also rests upon them. The petrol inlet is at J2, there being also the usual gauze filter chamber below the needle valve—J3. The air supply is at K, and the vapour outlet at K1. The air passage to the jet—J1—is through the channel between K2 and the carburetter wall. K2 is a ported casting fitted into the carburetter trunk, and formed cylindrical at its base, and at the top arranged to act on a sleeve or lantern, which is free to partially rotate subject to the movement of the lever arm—K3. The latter is attached to the governor spindle by means of a rod, so that the throttle is automatically operated by a lever at the will of the driver. In addition to the throttle sleeve there is fitted within, a sliding sleeve or tube—L—controlled by the spindle L3. inside the dome—K4. This spindle is free to also move vertically. A lever arm extends outside the dome, and is used to raise or lower the tube I. The lever controlling this is mounted by the steering column, and the object of the device is to enable the driver to vary the richness of the mixture at will to best suit the varying conditions of the atmosphere.

The functioning of the carburetter is as follows:—On starting, the tube L is at its lowest position, thus allowing a full volume of mixture to pass the vapour outlet pipe—K1. In that position all the air is passed round the casting K2 and up the tube L past the jet, and out into the vapour pipe, K1. The subsequent raising of L causes a portion of the air to pass directly through the part above the position marked K5 and through L4, thus forming as it were an auxiliary air medium, and so influencing materially the velocity of the air passing the jet. The base of the carburetter has hot water circulation where the inlet and outlet connection are shown at J5, with a drain tap at J7. It should be noted that the latter being the lowest point in the water circulation system is a convenient means of draining off the water from the tank and radiator in conjunction with a tap on the radiator.

The details of the carburetter dismantled are shown at Fig. 21.

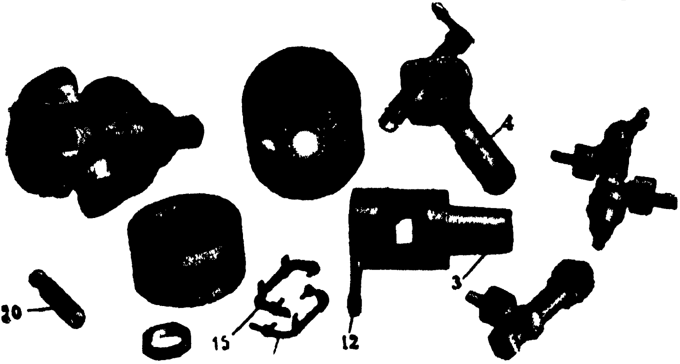


FIG. 21—DETAILS OF CARBURETTER (FIG. 20).

1, Mixing chamber; 2, Float chamber (showing base pieces for brackets 14 and 15); 3, Float; 4, Vertical or sliding sleeve (showing the ported section through which the mixture issues to the outlet K 1 (FIG. 20); 5, Semi-rotary sleeve or throttle in which tube 4 fits; 6, Petrol conduit containing filter and needle valve; 7, Jacket connection and conduit; 14 and 15, Cradle arms on which float (3) rests and which govern action of needle valve; 20, Needle valve.

THE TWIN CYLINDER CARBURETTER.

Type No. 3.

The type shown at Fig. 22 is fitted to the double cylinder De Dion motors. There are two separate jets, C,C,and two mixing chambers, J, J, but one float (A, A1) and float chamber (B, B1), and has a separate air supply for each. This consists in each case of vertical tubes of some length having air openings cut in their walls opposite the main air pipe of the carburetter. Inside these tubes are others fashioned to slide within them, and having air openings K, K, similar to those in the first tube. Thus by sliding the inner tube up or down, any required flow of air through the openings or ports can be obtained. The upper ends of the tubes are so connected that any motion of the operating lever M, fitted in the cover of the carburetter is communicated equally to both. The openings in the walls of these vertical tubes do not, however, form the only air inlet, for the carburetter is so formed that air can pass in freely through F and F1, and so be drawn up past the jets as shown by the line. Thus the extreme position of the sliding tubes corresponds to the extreme position of the regulator valve in the single cylinder carburetter when the whole of the air is bound to traverse the jet. The function therefore of the sliding tubes is to correct the rich mixture leaving the locality of the jet. There are four openings to this carburetter, two for air and two for the exit of the mixture, these openings being set symmetrically. When in position on the car, warm air is led to the air inlets E, E, by a pair of pipes. Two feed pipes, G, G1, lead to the valve domes of the engine, but a system of "throttling" is employed, which, instead of merely checking the amount of gas passing from the carburetter, also reduces the amount of air entering it, in like proportion, the result of so doing being to render the engine steady running and more flexible.

Fig. 22 explains the construction of the carburetter. The petrol enters through the inlet pipe O first, and passing through a wire gauze reaches the passage P. Here its access to the float chamber B, B1, is controlled by the needle valve, Q, which is set in the lower part of the plunger, Y. This plunger carries a screw, S, at the upper end, the head T of which rests on the end of the balance levers, which levers are free to oscillate on their spindles, V, V1, V, V2. The float, A, A1 rests on the levers. When the level of the petrol in the float chamber sinks, the float sinks with it, and acting on the ends of the levers, the latter act under the head, T, of the screw S, and so lift the plunger Y, and with it the needle valve Q, whereupon the petrol flows into the float chamber until the proper level is attained. The air enters through the air inlets E, E, as shown in the section; the whole volume of air rushes downwards through the air passages, F, F1, and then turning upwards passes the jets, C, C, and carries the petrol with it into inlet pipes, G, G1, and so to the engine. By the operation of the lever, M. however, the sliding tubes, J, J1, can be raised until the slots, K, K, come opposite the apertures I, I1, to the inlet pipe. Pure air is then admitted and mingles with the petrol-saturated air as both rise together to the inlet pipes, G, G1. The firing mixture is thus formed. The amount of pure air can be regulated by lifting the tubes J, J1 either to a greater or lesser extent. Z is the hot water inlet pipe, the object of which is to promote vaporisation of the spirit. The hot water passes through 1, and finds its egress through 2.

The diagram to the right shows the attachment of the sliding tubes, J, J1, to the lever M, and their method of operation by the lever N.

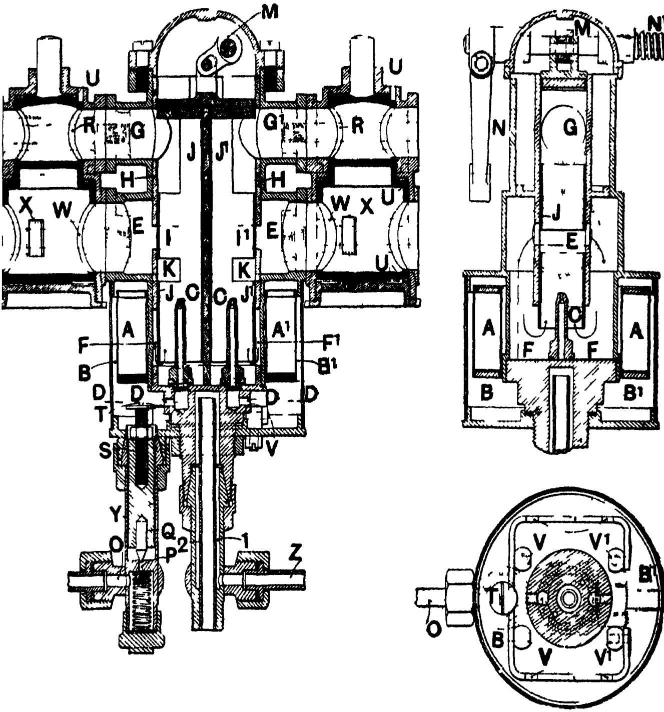


FIG. 22.—SECTIONAL ELEVATIONS AND PLAN OF THE DE DION TWIN CYLINDER CARBURETTER.

A A1, annular float
B B1, float chamber.
C C, jets.
D D, petrol passages.
E, air inlets.
F F1, air passages past the jet
G G, outlet pipes
H H, parallel bushes.
I I1, slots communicating with E E.
J J1, mixture passages, formed by sliding tubing.
K K, slots in tubes similar to I I1
M, lever actuating the sliding tubes.
N, regulating lever.
N1, spring locking the nut N2,
N2, lock nut
O, petrol inlet pipe
P, needle valve seat
Q, needle valve.
R R throttle valves openings.
S, adjusting screw.
T, head of adjusting screw looking over float contact levers
U (repeated), throttle valves
V V1 (repeated), float contact levers.
W W, air throttle openings.
X X, extra orifices in air throttles,
Y, float balance weight.
Z, hot water inlet pipe.
1, hot water inlet.
2, hot water outlet.

CHAPTER III.

SECTION I.—THE DE DION IGNITION SYSTEM.

General Features.

This is the most difficult subject which the novice has to grapple with, and at the same time the most important, for it is absolutely essential to the satisfactory running of the car that he should understand the means whereby the spark is caused which ignites the charge in the combustion chamber. Nine-tenths of the troubles with which motorists meet are caused by ignorance on this subject, or neglect of attention to the details.

The ignition mechanism consists of the following parts:

(1) The battery or magneto, from which the current originates.
(2) The induction coil, or intensifier.
(3) The switch or means of completing a path for the current.
(4) The contact breaker.
(5) The sparking plug.

We shall now describe these parts in detail.

The "Dry" Cell or Primary Battery.

(1) The type used in the De Dion vehicles is, with the exception of that used on the earlier four-cylinder models, of the primary or self-generative species; on the latter car an accumulator or storage battery of two cells (in one c[illegible] was first used. A word will, therefore, be [illegible]er on the construction and care of the accumul[illegible] storage battery in the interest of users who ha[illegible]elves substituted one for the primary cells supplied by the makers of the De Dion cars. It should be noted that the two and four cylinder models are now fitted with magneto ignition supplemented by primary cells —the latter for starting purposes only; and the makers have therefore reverted to the original form of battery and discarded the storage or accumulator type.

The De Dion "dry" battery furnishes its current by means of certain chemical changes effected in the composition of its elements. Strictly speaking it is not "dry," on the contrary, it is put together in a saturated condition and its failure very often points as much to the moisture having evaporated as to the components having been used up. The method for dealing temporarily with a run down or apparently exhausted battery is described in Chapter VI.—"Repairs and Adjustments." The De Dion "dry" battery consists of four cells linked together in series, and should register when new not less than 10 amperes. When this has fallen to 2½ amperes the battery should be replaced.

The Storage Battery or Accumulator.

The almost universal type of accumulator for motor use consists of a series of lead grids, suitably pasted or serrated and immersed in a bath of dilute sulphuric acid. These grids are cast in such a manner that when the paste, which consists of red lead for the positive plates and litharge (yellow lead) or precipitated lead for the negative ones, is pressed in, it will be firmly held in place notwithstanding the vibration and expansion on charging, or contraction on discharging, which it will be subjected to. When the plates have been pasted they are fitted in a case, usually made of celluloid, ebonite, or glass, the latter being protected by a wooden case. They are then subjected to a long, continuous charge till the plates have been formed, when the cell is ready for use. As all cells are sent out by the makers with plates formed the motorist need not trouble to know the details of that process.

In the case of a new cell, if sent dry, it should be filled up with dilute sulphuric acid, S.G. 1,200. In most cases it is better to get this ready mixed by a local chemist, as few motorists possess the necessary hydrometer to test the specific gravity of the acid. However, when pure brimstone acid is obtainable, one part (by volume) added to five parts of pure water will give a resultant mixture sufficiently reliable for all practical purposes. It is essential that the acid be added to the water, not *vice versa*, which should be kept stirred while the acid is being poured in. Only an earthenware vessel should be used for the purpose, and for similar reason no metal spoon should be employed to stir the mixture. The latter should be allowed to cool (for the acid will generate heat) before being poured or syringed into the cell. The battery should immediately be put on charge, and when doing so it is most essential that the positive plates of the cell be connected to the positive side of the charging "leads." In case of doubt as to which of the charging wires is the positive and which the negative, there are several ways of testing. The most usual way is by a piece of test or pole finding paper, which, when it has been wetted, both wires are placed on, about one inch apart. It will then turn red at the negative wire. Where no test paper is available, a simple method is to carefully measure the voltage of the accumulator, and then connect up to the charging "leads." Again carefully take voltage of accumulator, and if the voltage is now higher, however little, the cell has been connected up properly, but if it reads lower the wires must be changed over.

It is important that the charging rate should not exceed one-tenth ($\frac{1}{10}$) the rated capacity of the cell in amp. hrs. Thus if a cell is marked 20 amp. hrs., then the rate should not be more than 2 amps.

In the event of the cell not being marked the charging rate should not exceed 1 amp. for each 30 sq. inches of surface on positive plates. For example, suppose each cell contained two positive plates about three inches long by four deep, each side would contain 12 sq. inches of surface, and as there are two sides to the plate the surface of each would be 24 sq. inches.

Then, as there are two plates in each cell the charging rate would be 48 divided by 30, or approx. 1½ amps., which would be the correct charging rate. The condition of the cells may be judged by the colour of the plates. When fully charged the positive plates will have become a deep chocolate colour, and the negative a rich metallic grey. As the cell is discharged the positive plates will become of a yellowish red colour, and the negative darker and duller in colour. When the current is passing and the cells charged the voltage of each should be 2.6 or 5.2 for the double cell, which will gradually fall to 4.2 when the charging is stopped.

In no case should a cell be discharged when the voltage is below 1.8 for each cell, as such treatment will considerably shorten the life of the cell, and when used with the De Dion coil mis-firing will then be caused. Before confiding a battery to be charged in a strange place be certain to enquire if the supply current be a continuous one; if of the alternating type such is useless for cell charging purposes unless the current be transformed to a continuous one. For that purpose a rectifier has to be used.

The De Dion Magneto System.

The two and four cylinder De Dion cars are fitted with magneto ignition, working in conjunction with the ordinary coil and dry battery. The latter is, of course, only used for starting purposes, or as a stand by in the event of a breakdown of the magneto machine. Immediately the motor is started, by means of a commutator switch the battery circuit is destroyed and that of the magneto closed, the firing being thence provided by the latter medium. The magneto used is a special Bassee-Michel, and is of the simplest type, its purpose being merely to supply by mechanical means the purpose of the self-current producing medium or battery. The machine is shown in diagram at Fig. A, and the component parts thereof at Fig. B. The armature, 21, revolves at the speed of the crank shaft, and is driven by gear direct through the medium of the cardan-jointed spindle and sleeve, 20. It revolves on ball bearings, which it is only necessary to lubricate about every 200 miles. Its details comprise the five magnets, the armature 21, the condenser 27, the l.t. current terminal 26, the earth connection at 22, and the insulated plate which presses against the spring thrust pin, 25. At each half turn of the armature, the current, alternatively positive and negative, passes through the contact breaker at the moment when the intensity has reached the maximum. The simplicity and fewness of parts of the machine are illustrated in Figure B. The magnets, pole pieces, and base plate are shown at I, the armature and spindle at II, the front plate at III, the back plate at IV, the condenser at V, and the cover at VI. Nos. 21, 22, 24,

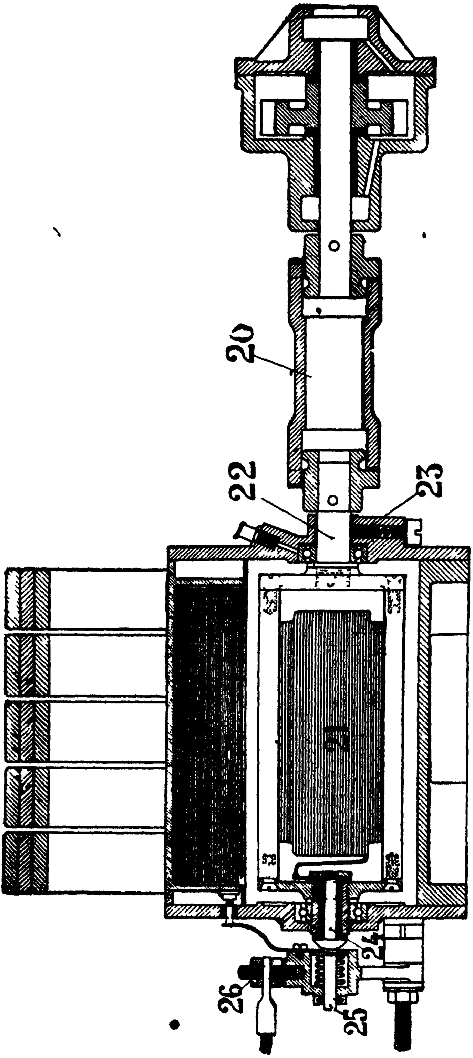


Fig. 4.—The De Dion Bassee Michel Magneto

and 26 denote respectively the armature's winding, the driving end of same, the insulated end of armature, and the terminal conveying the current to the coil—see plan of wiring, Fig. C. By noting carefully these components the user will be able to dissect and replace the magneto if required. It is, however, well to note that, generally speaking, a failure of the magneto is almost always due to a breakdown of the insulation in the armature or condenser, and cannot be repaired except by an experienced electrician. If at any time the armature is withdrawn it is necessary to bridge the magnets by a piece of steel or iron, failing which they will shortly lose their strength.

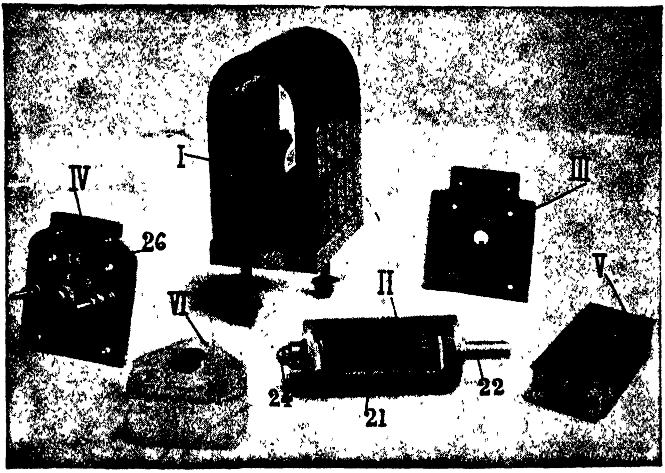


FIG. B.—THE MAGNETO'S COMPONENTS.

The Induction Coil.

(2) To understand its construction it is necessary to explain that, if a low tension current be run round a wound drum of copper wire, which is perfectly insulated from an outer drum of wound copper wire, at the make and break of this low tension current there will be "induced" a high tension current, the

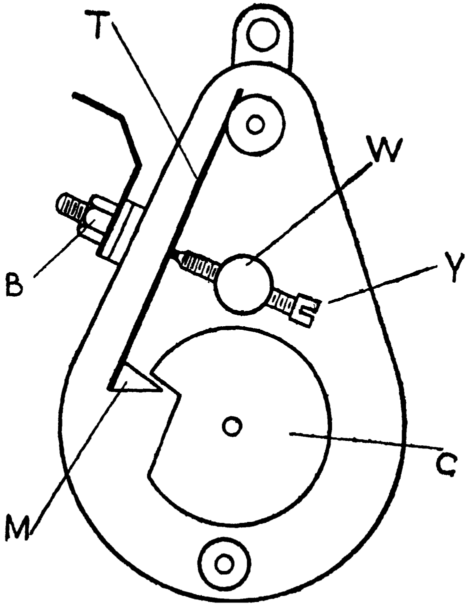
strength of which is increased to several thousand times that of the original or battery current. For a technical description of this instrument the reader is referred to the "Encyclopædia of Motoring."

The Switch.

(3) This is fitted to enable the driver to cut off the current and thus stop the motor.

The Contact Breaker.

(4) The object of this piece of mechanism is to momentarily make or complete the circuit path of the electric current to the coil, but what is more important, to ensure as rapid a break or rupture as possible, for upon this largely depends the correct working of the De Dion system.



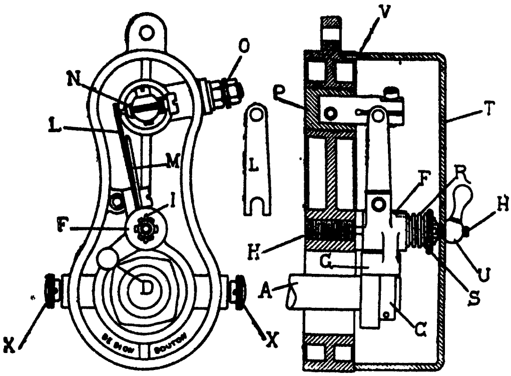
TYPE NO. 1.– FIG. 23.—CONTACT BREAKER FITTED TO THE EARLIER SINGLE CYLINDER DE DION MOTORS.

The type illustrated at Fig. 23 is now obsolete, but as it has all the elements common to the present De Dion ignition system, the cycle of operations may be just as readily grasped. The contact breaker is operated by the two-to-one shaft. A pear-shaped metal base plate carries the studs to which are secured the steel contact blade T and the platinum tipped screw Y. C is a cam fixed on the two-to-one shaft, and consequently revolves once for every two revolutions of the motor shaft. T is the contact blade. It has a wedge-shaped piece of metal fixed to one end, and when the wedge rests in the centre of the slot, as depicted in the engraving, the centre of the contact blade should be in contact with the end of the screw marked Y.

The two points of contact are made of a special but expensive metal, of a hard and anti-fusing nature. It is therefore necessary to see when replacing one or both that a similar pattern be used, as if the material be soft, or easily fused, the points will be constantly requiring attention and adjustment. The screw A which passes through W secures Y in position.

Now, supposing the switch to be in position. the current flowing through the coil from the battery will run through the stud B and stub W (which are in contact inside the base plate), and thence through the screw Y to the contact blade T. When the points are brought into contact the blade should be in contact with the end of screw Y. From the contact points the current will flow to earth by the base plate, and so through the frame back to the — pole of the battery, which is earthed to the frame by means of a wire, thus completing the circuit

When the engine is working, the cam C will, of course, be revolving, and the wedge at the end of T will rest on its periphery, except at the place where the notch occurs Consequently, it will be seen that it is only when the wedge M, at the end of the blade, T, falls into this notch that the circuit path for the current is established, and will continue as long as the blade and screw are in contact. The reader should note the exact position of the wedge piece, as shown in the illustration, for it is essential to the correct working of an engine fitted with this contact breaker that the blade should not fall any deeper in the notch than there shown. More detailed reference to the subject will be found in Chap. VI.—" Repairs and Adjustments."



TYPE NO. 2.—FIG. 24.—SECTIONAL VIEWS OF NEW PATTERN CONTACT BREAKER NOW FITTED TO ALL LATEST PATTERN SINGLE AND FOUR CYLINDER DE DION MOTORS.

A, cam shaft.
D, trembler type cam.
N, oscillating contact arm.
G, side view of F
H, stud screw and spindle on which F works.
I, pin with recesses for lockings.
L, contact blade.
M, do , secondary blade

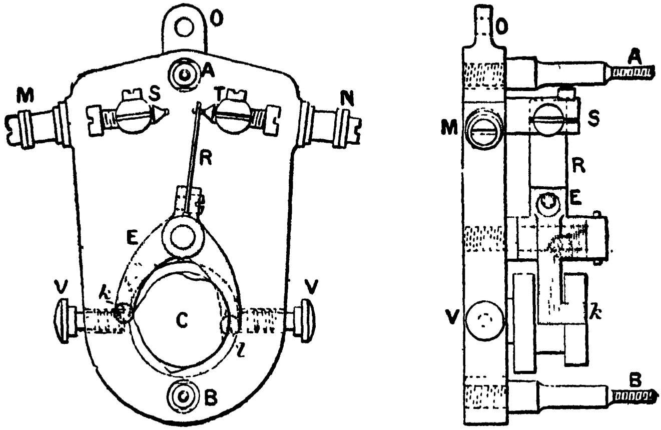
N, adjustable contact screw.
O, circuit wire, terminal.
P, insulator.
R, adjustable spring for F
S, notched nut for same.
T, dust cap over contact breaker.
U, finger nut for do.
V metal plate of do.
X, spring locking bolts for do.

The contact breaker shown in diagram Fig. 24 is now fitted to all De Dion motors excepting the two-cylinder models, but in the case of the single-cylinder motors the tumbler block has only one cam, whereas as shown four will be noticed, that being the type used on the four-cylinder engine. This has what is known as synchronised ignition, as it ensures exact accuracy in firing the gases in the respective cylinders.

The action is the reverse of that used in the previously described pattern, the contact blade, L, being pressed against the point of the screw N, by means of the crank F, and influenced by the cam like action of the tumbler D. Inserted in, and attached to the boss of the lever F is a spring, the tension of which is adjustable by the nut S. The object of the spring is to keep the end of the oscillating contact arm F always in contact with the periphery of the tumbler D. The contact breaker is held in place by the bolts XX. These in turn are pressed home by springs inserted in the recesses of the bosses at XX. Only one circuit wire—O, the positive—is needed, the return or negative current being taken through the metallic plate of the contact breaker itself. The method of wiring the De Dion car will be treated of separately.

The contact breaker now used on the 10 and 12 h.p. De Dion two-cylinder motors much resembles the type just described. The method of action and of adjustment are the same; the only points of difference are, that in the latest type two contact blades are used. The contact blade has also been strengthened by a stiffening blade, similar to that used in type No. 2, Fig. 24.

It will only therefore be necessary to deal in detail with Fig. 25. The contact breaker consists of an insulated metal base plate which forms the return path for the current; hence, as in the other types, no earth wires are needed, and the terminals M.N. are for positive wires for the respective cylinders. C and C1 are two separate cams mounted on the half speed shaft, while E is a fork with a central arm. At the ends of the fork are two hardened steel stub-pieces, one of which—K—is shown, the other--l—is only partly visible in the illustration; as each faces in the opposite direction. Thus the one—K—forms a rubbing contact with the periphery of the front cam—C, while the other makes similar contact with the rear cam, C1. The alternate oscillating about its axis of the fork E causes the contact blades to alternately make contact with the screws S and T. This takes place when the respective cams reach their furthest point of travel. As the space between the screws S and T is obviously limited, it is necessary to provide clearance in the corresponding cam. This is obtained by recessing or grooving the cams at the point in question, thus when—for example—the cam C is in the position shown in Fig. 25 , the blade is in contact with the screw T, and the stub —l—which engages with the rear cam--C1--is in the recess on that cam, which thus gives the necessary clearance and dispenses with the necessity for using cams with bigger projections, and enables the screws S and T to be brought closer together. The current flows from the positive terminal of the battery to the coil, and through the coil to



Type No. 3—Fig. 25—Illustration of Contact Breaker used on the earlier De Dion two-cylinder motors.

A and B, stud pieces which carry the dust cap covering the contact breaker.
C and C_1, cams.
E, forked bracket which carries contact blade.
k and l, projecting studs attached to ends of E.
M and N, positive terminals for wire from coil.
O, base plate of contact breaker
S and T, contact screen.
V and W, spring held bolts, holding contact breaker in place.
Z, spring pressing K against cam C.

terminals M or N, according as the circuit is closed for each cylinder. When contact is made, the current flows through screw S or screw T to the blade, thence through the pin on which fork E oscillates to the base plate and traverses the frame back to the battery. Thus a common battery terminal serves both coils.

The Sparking Plug.

(5) The sparking plug is the medium for firing the gases in the combustion chamber. As the pressure at that moment is little short of 280 lbs. to the square inch, it is obvious that the plug must itself be internally pressure tight as well as at its exterior jointing at the combustion chamber. The core of the De Dion plugs is made of a special heat-resisting quality of porcelain, carefully baked and annealed. Through the centre runs a metal rod,

having at its lower end a short piece of an anti-fusing alloy. This latter is bent over to face a similar piece of material, which latter is bedded into the wall of the metal exterior of the plug. The ends of both wires are in close proximity, being separated by a distance of 1-32nd of an inch, a point the De Dion user should note. The central wire which is the positive pole—the other being the earth or negative pole—is made taut in the porcelain by a special cement—a speciality of the De Dion firm (who also make the plug in its entirety)—which has the peculiar feature of expanding when hardening. The porcelain is moulded with a shoulder, and rests on a copper sheathed asbestos washer, a similar one being also placed at the top. A screw metal gland holds all in place, the washer acting both as a cushion, partially insulating the porcelain from the vibration, and as a gas tight jointing. Sparking across the gap at the points takes place when the high

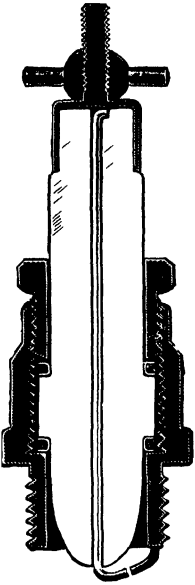


FIG. 20.—SECTIONAL VIEW OF THE DE DION SPARKING PLUG.

tension current runs along the heavily insulated wire from the coil and passes through the wire in the centre of the plug. At the break of the low tension current it jumps across the interval between the end of this wire and the short piece of wire fixed in the metal body of the plug, and thence passes through the frame of the car back to the coil.

Diagram of Wiring used on the De Dion Cars.

Having described the various portions of the ignition mechanism and their functions, we shall now proceed

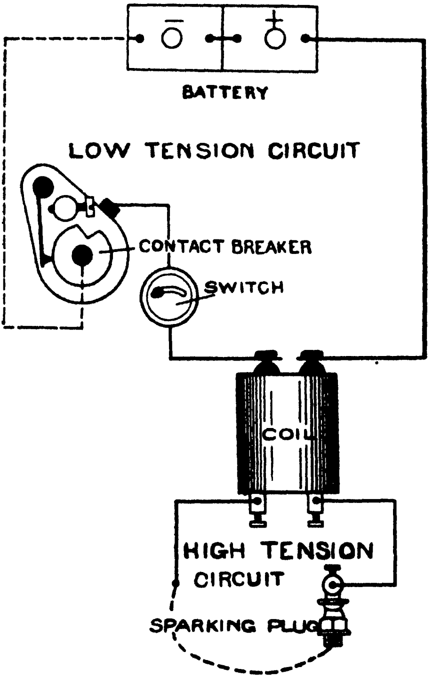


FIG. 27.—DIAGRAM OF ELECTRICAL CIRCUITS.

—with the aid of a diagram—to trace the entire operation firstly in an explanatory fashion, and then by reference to the models used on particular De Dion engines.

Starting from the battery (irrespective of its type), the dark line on the diagram—Fig. 27—shows the path taken by the current as it starts from the + or positive terminal of the battery. It runs directly to the P, or "Pile," terminal on the coil, whence it traverses the low tension wiring in the coil. At the end of that coil of wire—commonly called the primary winding—there is affixed another terminal generally marked "Allumeur," from which a wire is led to the contact breaker. It will, however, be noted that a *switch* is interposed in the circuit. This may be either a separate switch, or attached to the coil. The current passes from the contact breaker each time the blade falls into the notch, and makes contact with the screw. It finds its way back to the battery through the frame and a wire which connects the frame to the battery terminal, thus completing what is called the low tension or primary circuit.

The high tension, or secondary current, like the primary must also have a complete circuit. It starts from the high tension drum of the coil, and passes out to a terminal from which an insulated wire runs to the sparking plug and is attached to same by means of a screw. It is thus brought into contact with the wire which passes through the porcelain of the plug to the inside of the combustion chamber. (See Sparking Plug.) When the spark takes place the current is conveyed from the metal portion of the plug into the motor and frame, and through a wire connected to the frame returns to the coil, thus completing the high tension or secondary circuit. The lower portion of Fig. 27 explains how the circuit is completed, the heavy and dotted lines showing the path of the current through the motor and frame. It will be observed from this that in order to get a spark, there must be two complete circuits; these circuits must be uninterrupted throughout, except at a set interval by the contact breaker, and the battery must be in a satisfactory condition.

Types of De Dion Wiring from Battery to Coil.

Fig. 28. shows the arrangement of the wiring on the early De Dion motors, and is now obsolete The reader should in all cases carefully note the marking of the coil and compare same with the car he is using.

The path of the current runs from the + terminal of the battery to P on the coil, thence traverses the coil and passes through terminal—M—to the stub—a at the contact breaker thence from b the contact blade terminal, whence it is earthed, as shown, and returns past the switch (one terminal of which is also earthed), and interrupter plug to the negative (—) terminal of the battery. The secondary or high tension current passes by a heavily insulated wire to the spark plug, and is earthed through a metal band which encircles the coil case. It is, therefore, important to note that the switch be closed and the interrupter plug is in position before attempting to start the motor.

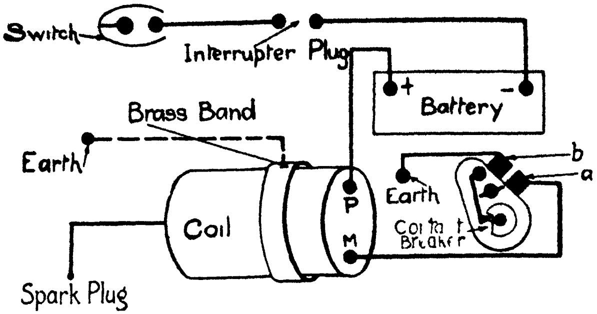


FIG. 28.—WIRING USED ON EARLY DE DION MOTORS.

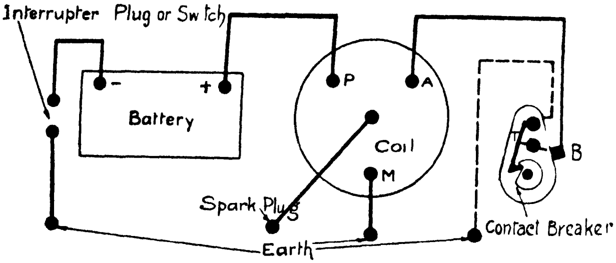


FIG. 29.—PLAN OF WIRING USED ON THE LATER SINGLE CYLINDER DE DION MOTORS.

Fig. 29 shows the method of wiring the later single cylinder motors. There are three terminals on the coil. The battery lead is connected with terminal P and the contact breaker wire runs from terminal A to B, the terminal B which is connected to a metal tipped screw, and thence into the blade, T, when the contact points come together. There is only one terminal on the contact breaker plate, the return current being earthed by the metal base plate of the contact breaker. A separate terminal M provides for the return of the high tension current. The negative pole of the battery is earthed, and the return current passes through the interrupter plug as shown. Thus the current runs from the battery to terminal P on the coil, thence through the coil to terminal A, and thence to terminal—B—on the contact breaker. It passes thence through the metal tipped screw attached to B, to the blade T, and the metal base-plate to earth, whence it traverses the metal part of the chassis, past the interrupter plug or switch and returns to the negative (—) terminal of the battery. The high tension current runs from the terminal on the face of the coil case to the plug, and returns through terminal M, which is earthed to some convenient part of the frame.

NOTE.—It may be well to add that in the later models of De Dion motors the interrupter is differently placed, and the lettering on the coil is not the same. Thus the + wire of the battery runs to the interrupter, and thence to the terminal marked P on the coil. The + wire of the battery is earthed at any convenient part of the frame. From the terminal M on the coil a wire is led to the ter-

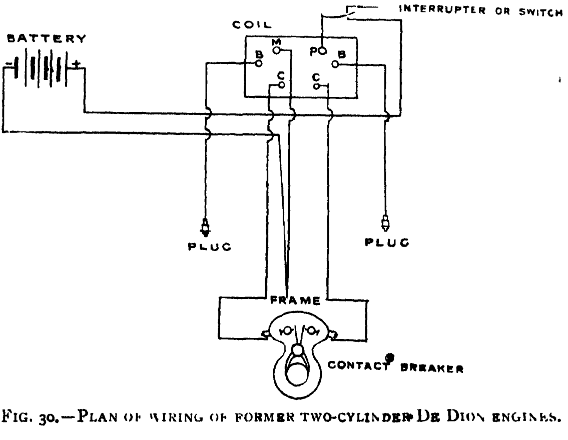


FIG. 30.—PLAN OF WIRING OF FORMER TWO-CYLINDER DE DION ENGINES.

minal on the contact breaker. From the B terminal on the coil the high tension wire is led to the sparking plug. The newer system is, however, only a simplification of the other.

Fig. 30 shows the plan of the wiring used on the two cylinder De Dion engines. The wire from the + terminal of the battery is led to the switch or interrupter, and thence to the terminal P on the coil. The two wires C.C. are led to respective terminals on the contact breaker. The earth or return current is through the base plate of the contact breaker and the frame to the — terminal of the battery. A similar wire is led from the terminal M on the coil to complete the high tension circuit. The high tension current is led from the terminals B.B. of the coil to their respective plugs.

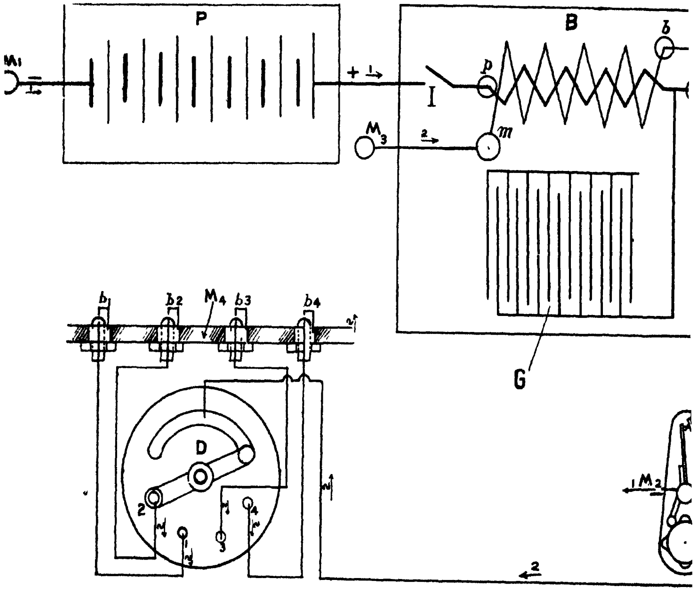


FIG. 31.—PLAN OF WIRING OF EARLIER FOUR-CYLINDER DE DION MOTORS. (Not fitted with Magneto Ignition.)

Fig. 31 shows method of wiring the earlier four cylinder De Dion engines. The current runs from the + terminal of the battery P, to the interrupter I, thence to the terminal p on the coil—B—thence from terminal--a--on the coil B to the contact breaker A, and is earthed at M2, whence it passes through the frame to the negative terminal of the battery—M1, which completes the primary circuit.

The high tension current flows through the condenser C of the coil from the terminal m to b, thence to the insulated distributor D, and thence through the terminals 1, 2, 3, 4 to their respective plugs, b1, b2, b3, b4, the negative or earth return being through the frame to the terminals M4 and M3.

The method of distributing the h.t. current to the sparking plugs in the four cylinders is by no means as complex as would at first sight appear. The cam shaft D—Fig. 16—has attached a spiral gear wheel—E—which drives at one-fourth the engine's speed the vertical spindle E1 (Fig. 32). Near the top of the spindle is affixed the metal

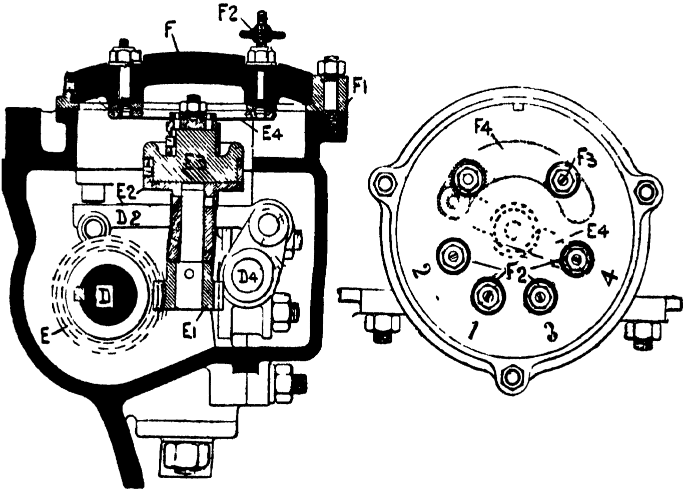


FIG. 32.—CROSS SECTION AND PLAN VIEW OF THE HIGH TENSION CIRCUIT DISTRIBUTOR USED ON THE FOUR CYLINDER DE DION CARS.

cup, E2, containing the porcelain current distributor E3. Attached to the porcelain—the object of which is to insulate the distributor from the spindle, E1—is a flat metal strip—E4—which is revolved by the spindle E1, but is insulated from it. Surmounting the metal strip piece—E4—is a porcelain cover—F---which is affixed in the metal box, F1, and forms also a dust cap over the mechanism. The four high tension terminals or leads to the sparking plugs and the terminal, F3, attached to the metal piece, F4, on the inside of the box are shown in the plan view—Fig. 32. The h.t. current is conveyed from the coil to the terminal—F3—and thence through the metal segment piece, F4. Thus while the metal strip, E4, is being revolved it makes contact in sequence with the h.t. current terminals 2, 1, 3, 4, the other half of the arm being for the time in contact with the segments piece, F4, the revolving of E4 causing an alteration in the relative position of the arms of the metal strip, E4, which latter, it should be noted, has a spring-like action to ensure a firm contact with the terminals. The user should note the order of the firing in the cylinders, as shown in the plan view of the distributor, though with characteristic pre-vision the makers have stamped the respective terminal numerals on the face of the porcelain insulator.

The De Dion Magneto.

Diagram C shows the method of wiring the four cylinder De Dion cars fitted with the magneto and ordinary battery ignition; the systems being in duplicate—*i.e.*, the one is supplementary or alternative to the other. A similar arrangement is used for the 1906 model two cylinder car, which it is therefore not necessary to deal with in detail.

The chief points to note are the inclusion of the commutator or switch, which alternately cuts out the magneto or battery as desired. The engine is started with the switch (which is shown in the diagram in the neutral position) in contact with the P (battery) terminal.

Before starting the engine the switch is moved over to the P contact point. The primary current then flows from the terminal (3) of the battery (Piles) to the terminal (4) on the coil. It then flows to the lowest of the three terminals shown on the side of the coil box, thence to terminal P of switch, to the central or common terminal on same. It thence flows to the middle one (shown on side of coil box), through the plug switch—5, through the primary winding of the coil to terminal 6, whence it makes its way to the contact breaker, 7—and is earthed by wire 8. The negative terminal of the battery is similarly earthed by the wire from 2 to 1.

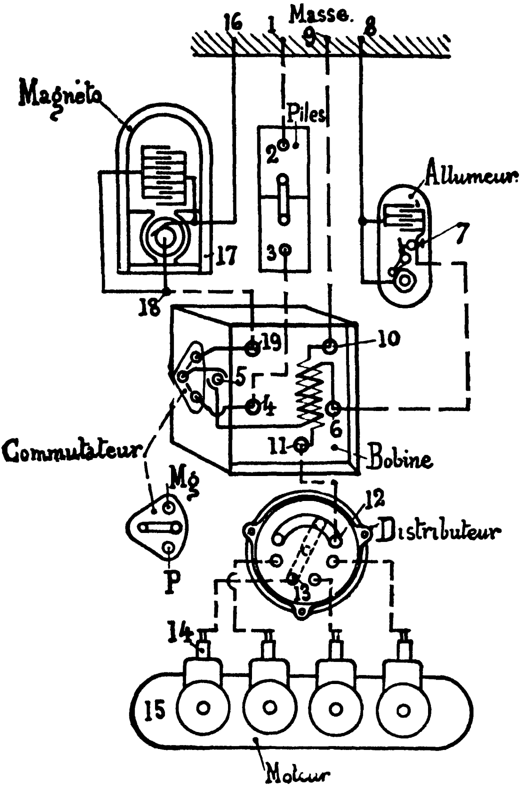


FIG. C.—DIAGRAM OF THE WIRING OF TWO AND FOUR-CYLINDER ENGINE FITTED WITH MAGNETO AND BATTERY IGNITION.

[NOTE.—On the two-cylinder engines only two—h.t.—wires are led from the distributor to the plugs.]

The secondary circuit commencing at the terminal 11 leads to the distribution terminal and contact plate 12. It is thence conveyed in turn by the rotation of the contact arm, 13, to the respective sparking plugs, 14; the corresponding terminals and their respective wiring being shown by the dotted lines. The earth return is in the ordinary way through the metal of the plugs and the engine and the chassis.

As soon as the engine is started the commutator switch is moved over to the terminal marked Mg (Magneto). The battery current is thus cut off, and the magneto armature, which is now running at, say 1,000 revs. (*i.e.*, the same speed as the crank shaft), takes up the firing. The primary circuit path is then as follows —The current flows through the wire 18 from the insulated end of the armature spindle to the terminal, 19, of the coil, thence to the top terminal at the side of the coil box, and is thence led to the terminal—mg of switch. It traverses the bridge piece at the centre of switch back to the central terminal on side of coil box, and through plug switch, thence follows the same circuit course as before described, *i.e.*, through the primary winding of the coil to the contact breaker 7, and thence to earth at 8, completing the circuit through 16 to 17 on the magneto. The secondary circuit path is as above described—*i.e.*, from terminal 11 on coil to 12 on the distributor, and thence to plug 14, the latter being earthed at 15.

SECTION II.

THE DE DION TRANSMISSION SYSTEM, INCLUDING THE CLUTCH AND BRAKES.

A.—The Expanding Clutch.

Up to 1905 all De Dion cars were fitted with expanding clutches, contained in the gear box. The clutches were metal segment blocks, fibre covered. This type of clutch mechanism is now only used on the small powered car. The other types are fitted with the form of sliding change speed gears, shown in Fig. 35—page 57—and the disc clutch, Fig. 36, page 58. Before passing on to the gears, the expanding clutch, Fig. 33, must first be noticed. The illustration shows its general features and the details will be readily grasped. A pair of fibre-covered segments—C and C1—are caused to engage with the internal periphery of the drum—A—by the in-and-out moving of the long spindle, E. The latter, it will be noticed, has a right and left handed cork-screw style of thread—E1 and E2—which engage with the pinions, F and G, the latter forming one with their short spindles, these in turn being similarly screwed with a moderately coarse-pitched left (F1) and right (F2) thread. The method of adjusting the clutch segments is dealt with in Chapter IV.—"Care of the Engine and Car."

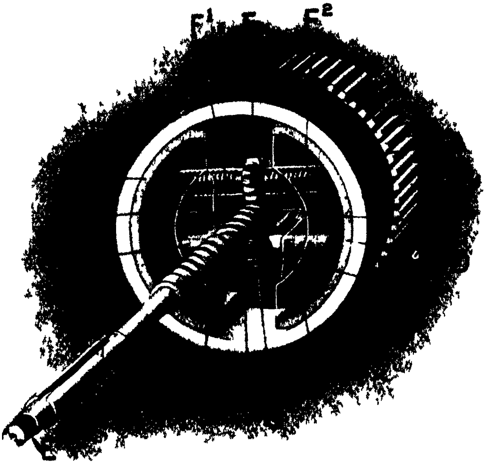


FIG. 33. THE DE DION EXPANDING FIBRE COVERED CLUTCH.

A, Clutch Box, B, Pinion, C, Clutch segment, C1, Clutch segment, D, Vulcanite fibre surface on C, D1, Vulcanite fibre surface on C1, E, Double screw rack, E1, Right hand screw of E, E2, Left hand screw of E, E3, Groove on channel in E, E4, Screw end of E, F, Small pinion, F1, Axis or extension of F with left hand screw, F2, Axis or extension of F with right hand screw, G, Small pinion, H, Tapered sleeve in which extension of G works, H1, Tapered sleeve in which extension of G works.

[Messrs. De Dion-Bouton, Ltd., Gt. Marlborough St., Regent Street, London, W., have issued a separate and explanatory detailed circular dealing with other types of expanding clutch gears fitted to former models of the De Dion cars. These may be obtained by customers on direct application to them.]

Fig. 34 shows the 6 h.p. gear box in part section. The two clutches in the boxes, X2 and H are fixed to the shaft C, and are expanded by the rack which is contained in the hollow shaft, M. Drawing the change speed lever towards the driver expands the clutch in the box X2, and causes the car to be driven through the middle speed combination, X and X1. Pushing the change speed lever away from the driver expands the clutch in the box H, and this gives high speed. Then the

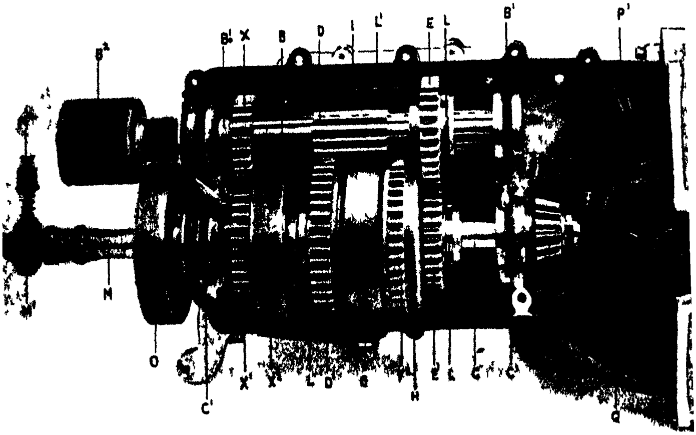


FIG. 34—SECTIONAL VIEW OF 3 SPEEDS FORWARD AND REVERSE EXPANDING CLUTCH GEAR BOX.

clutch box is in the normal position, through the pinions E and E1, but by pressing down the right pedal, the two boxes G and H, with the pinions D1, E, and E1, also clutch box H with fixed gear wheel F2, are drawn backwards in the box, so that the clutches normally in clutch box H come inside the clutch box G; then the drive is taken from D, through D1, thus forming the low forward speed. To obtain the reverse (the right pedal not being depressed and the clutches in neutral position) a lever on the side is pressed forward until the catch—L1—engages in the notch. This movement draws the pinion E backwards out of mesh with E1, and introduces an intermediate pinion (not shown) already in mesh with D into the teeth of the wheel, F2, on the box H. Thus when the clutch is expanded in the box H, the car will be driven in the reverse direction.

B.—Transmission Gear now used on all high-powered De Dion Cars.

The gear illustrated by Fig. 35 is now being fitted on all higher powered De Dion cars With the substitution of the sliding type of gear the De Dion cars are now also fitted with a new disc form of clutch. This will be found described under Fig. 36, and its features are common to all the cars fitted with sliding pinion gears. The gears on the shaft R are fixtures with it, but those on the lower shaft, R5, are mounted on a sleeve, which is free to slide end-wise to enable any of the corresponding wheels to be meshed with its fellow. A ball "thrust" bearing is interposed at the rear of the bevel wheel—R10.

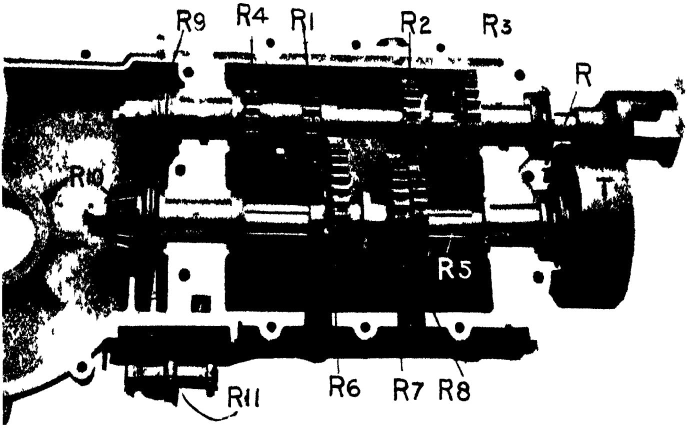


FIG. 35—STANDARD THREE SPEEDS FORWARD AND REVERSE SLIDING TYPE GEAR.

R, Primary shaft, R1, First speed wheel, R2, Second do , R3, Third do , R4, Reverse wheel, R5, Secondary or lay shaft, R6, First speed gear wheel, R7 Second do , R8, Third do , R9, Worm driving oil pump, R10, Bevel pinion R11, Oil pump for lubricating gears

The reverse gear is brought into effect by sliding the wheel—R6—into mesh with the near member of the two lower placed wheels (to be seen at the side of the gear box below R4. The efficient method for oiling the shafts and gears, will be found treated under the head Lubrication—Chap IV.

The De Dion Disc Clutch.

The De Dion disc clutch is operated through the medium of a light metal disc acting against the face of a fixed clutch member, bolted to, and forming part of the fly wheel on the crank shaft. To prevent any possible "scoring" of the metal faces incidental to a rubbing action, small anti-friction plugs are inserted between the clutch faces. Fig. 36 shows the clutch in section; and Fig. 37 the principal parts composing it. These latter comprise, the large disc—M—which is bolted to a flange at the end of the crank shaft, the rim of fly wheel—M1, the clutch disc—P, the flange piece—M3, and the outer cover—M8. The whole are coupled *en bloc* by bolts which pass through holes in the rim—M1. The "Automotor Journal" thus describes the features of the clutch's mechanism:—"The disc— M3—has a sleeve projecting from its centre, and this sleeve is bushed internally to form a bearing for the clutch-shaft, P1—to which the disc, P, is bolted. The casting, M3, is fitted with a number of pins, M5, that project inwardly, these pins forming guide carriers for the movable friction-ring, N. The ring, N, is therefore capable of moving inwards and outwards on these pins. It is normally pressed up against the disc, P, by a number of helical springs, M7, that are fitted inside small casings, M6, which project through the casting, M3. All these springs act upon a thin ring, N1, which is introduced between them, and the friction-ring, N, and thus the springs tend to act equally all round in clipping the disc, P, between the friction ring, N, and the friction-ring, M2. The face of the friction-ring, N, is provided with anti-friction plugs like those in the fixed ring, M2, and both these rings are webbed out on their other sides in order that they may be kept cool by a current of air, which is caused to pass around them.

"The casting, M3, has four holes, M10, drilled through

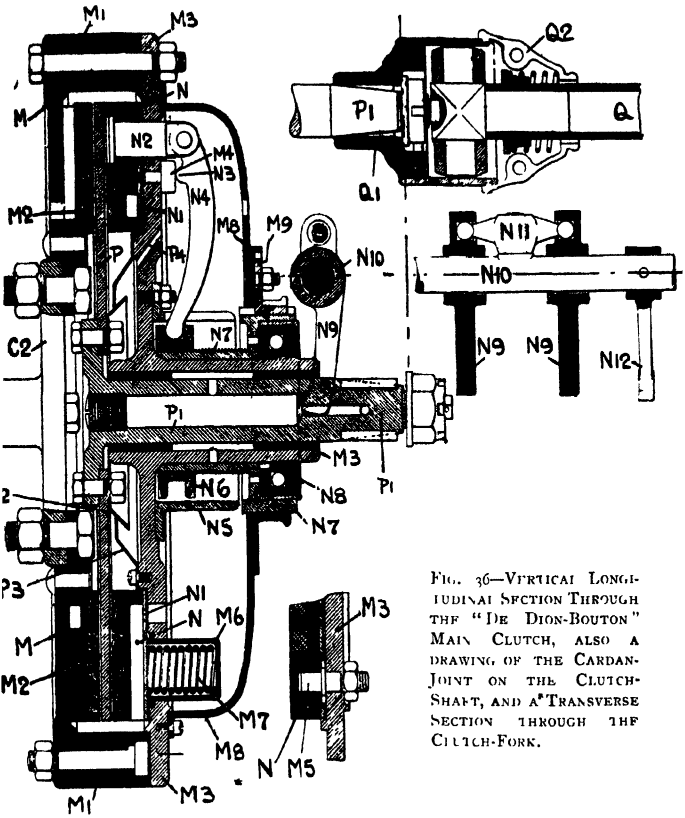


FIG. 36—VERTICAL LONGITUDINAL SECTION THROUGH THE "DE DION-BOUTON" MAIN CLUTCH, ALSO A DRAWING OF THE CARDAN-JOINT ON THE CLUTCH-SHAFT, AND A TRANSVERSE SECTION THROUGH THE CLUTCH-FORK.

The Clutch.

M	Front flange of flywheel.
M1	Rim of flywheel.
M2	Friction face block fixed to M.
M3	Rear flywheel casting.
M4	Fulcrum studs in M3.
M5	Driving-pins fixed to M3.
M6	Caps containing clutch-springs.
M7	Clutch springs.
M8	Outer cover of clutch.
M9	Locking-catch for adjustment.
M10	Holes in M3 for pins, N2.
N	Moving friction block carried by flywheel.
N1	Disc fitting against same.
N2	Fulcrum pins fixed to N.
N3	Projections on levers, N4.
N4	Operating levers.
N5	Guide casting for levers, N4.
N	Collar, engaging levers, N4.
N7	Sliding sleeve carrying collar, N6.
N8	Ball trust for sleeve, N7.
N9	Clutch fork members.
N10	Shaft carrying levers, N9.
N11	Compensating device.
N12	Operating lever.
N13	Guide holes in N for pins, M5.
P	Clutch disc.
P1	Shaft carrying disc, P.
P2	Oil thrower fixed to P.
P3	Oil catcher fixed to M3.
P4	Oil ways through M3.

it, and through these holes project small fulcrum pins. N2. The fulcrum pins are secured to the friction-ring, N, at one end, and have lever arms, N4, pivoted to their outer ends. It is these four pins, N2, that enable the friction-ring, N, to be drawn back clear of the disc, P— against the action of the springs, M7—for the lever arms, N4, have small projections, N3, formed upon them, close to their fulcrums, and they are at their extreme ends engaged in a grooved collar, N6, that can be moved longitudinally along the shaft. The projecting portions, N3, of the levers, N4, rest up against small hardened-steel stops, M4, that are fixed to the casting, M3, so that these projections, together with the stops, M4, in reality constitute the fulcrums about which the levers, N4, work. The levers, N4, pass through slots that form guides for them in a sleeve, N5—which is fixed to the casting, M3, and encircles the collar, N6—while the collar, N6, is prevented from rotating about its axis by small pins that are fitted across its groove (as seen in Fig. 37) on each side of the levers, N4.

"The grooved collar, N6, screws over a sleeve, N7, which is free to slide on the outside of the casting, M3, and this sleeve, N7, has a ball-thrust bearing at its outer end, against which presses the clutch-fork, N9. The action of the springs, M7, tends to move the sleeve, N7, outward, so that when the clutch-fork, N9, forces it inward, the clutch is disengaged. The only adjustment needed is provided by the screw thread between the sleeve N7, and the collar, N6. The sleeve is prevented from turning (except when making this adjustment) by a small catch, M9, which is fixed to the aluminium casing, M8, and rides on a slot in the sleeve, N7. When the catch is withdrawn, the sleeve, N7, can be screwed in or out to the desired extent to adjust the position of the clutch pedal, and to compensate for any wear on the friction surfaces of the clutch.

Each of the friction rings, M2 and N, is rendered extremely rigid, but is given a large cooling surface by being webbed out on the side furthest away from the disc, P.

Holes are provided in the front flange, M, of the fly-wheel for the ingress of air, and again in the back outer cover, M8, for the egress of air, these being in addition to those in the rim—M1, the object being to provide efficient air

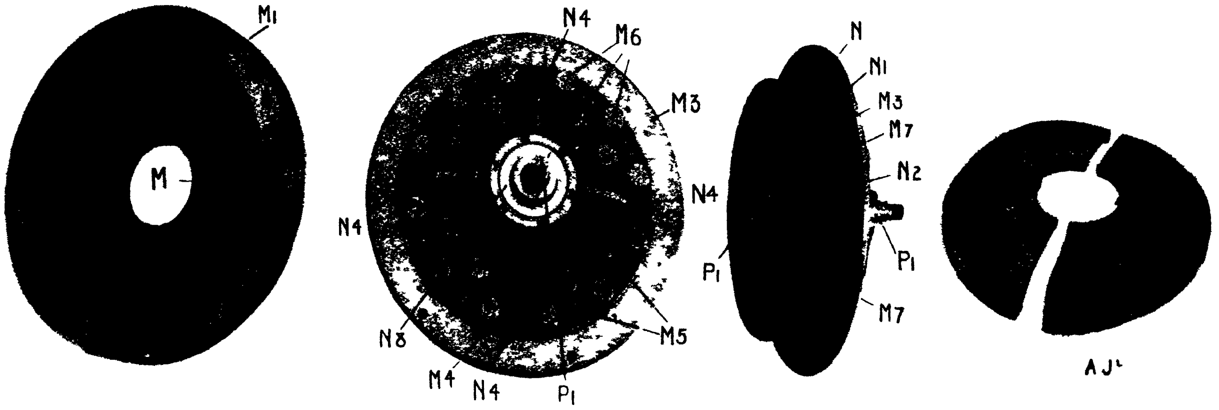


Fig. 37—The De Dion Bouton Disc Clutch. Views of the flywheel proper with its inner friction face, of the other portion of the clutch removed from the flywheel, side view of the same portion and a view of the external casing

cooling over the friction rings' surface while the clutch is revolving.

It will be noticed that an oil-thrower—P2—is fixed to the disc, P (Fig. 42), and that a corresponding oil-catching ring—P 3—is secured to the casting, M8.

The adjusting of the clutch is dealt with in Chap. IV. —"Care of the Engine and Car."

The Brake Gear

The brakes on all the later De Dion models are two in number, *i.e.*, a foot brake and a hand brake. The foot brake is operated by the same pedal that actuates the exhaust regulator, so that the engine is primarily slowed down before the brake is applied. It operates on a drum set just forward of the gear box, attached to the hollow clutch shaft, and is both double acting and adjustable. Still greater facility of adjustment is offered in the shape of a hand nut—32—which is easily accessible. The hand lever brake formerly operated two band brakes which grip the outside circumference of two drums fixed one to either road wheel. This brake was adjustable by means of threaded shackles on the coupling rods.

On the recent models, the brakes, actuated by a side lever, are expanded in drums attached to the hubs of the driving wheels, and may be readily adjusted by hand grips.

FIG. 38—GEAR SHAFT BRAKE FITTED TO 1905 DE DION CARS.

Fig. 38 shows the gear shaft brake fitted to all present models of De Dion cars

The two segments—28—are pivotted to lug brackets, which form part of a transversely placed tube on the frame. The adjustable and reversible brake shoes are shown at 26, and the centreing screws for same at 27 The compensating link and rods equalising the pull on both segments are visible at 29 and 30, and the simple method of adjusting the "bite" of the brake at 32 (the fly nut is operated by hand pressure) and 33, the tensioning screw attached to same, while 34 is a spring slipped over the screw—33—and interposed to ensure the brake shoe being kept "off" the drum—8 The coupling rod—24—and the bell crank lever—25 complete the details of the gear shaft brake

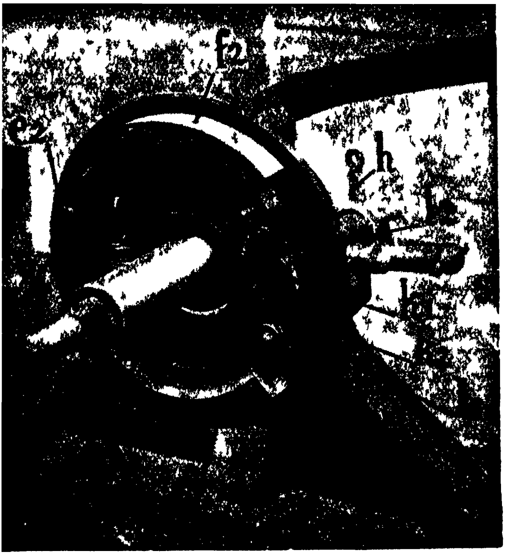


FIG 39—EXPANDING REAR HUB BRAKES FITTED TO ALL THE 1905 DE DION CARS EXCEPT THE 6 H P

The rear axle brake, Fig 39, works expandingly, *i e*, the previously described method of operation is reversed F1 and F2 are the expanding segments pivoted on pins, one of which—e2—is to be seen attached to a disc plate on the axle sleeve. The brake blocks are kept in the "off" position by a tension spring to be seen at the rear of the axle sleeve. The other ends of the brake blocks are linked to the toggles I1 and I2, which, in turn, are coupled to the crank arms, K1 and K2, of the spindle which carries at its outer end the lever h. Adjustment of the brake blocks is provided by the worm and worm-wheel—n, Fig. 40. The boss of the lever arm—h—is not keyed to the brake shaft, but is bored to receive the worm nut, which may be rotated through the worm—n—by the small handle, s. The end of the brake shaft is made square to receive the nut, hence it is possible to adjust the position of the brake blocks without any

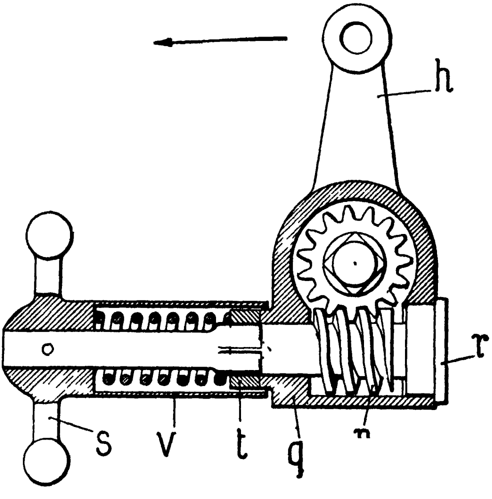


FIG 40—REAR BRAKE ADJUSTING GEAR

reference to the lever—h—or any of the connections operating the brake gear. The worm is automatically locked by a special cam-like washer—t—which is pressed home by the spring, V. It may be well to remark that the foregoing remarks apply to the 8, 10, 12, and 15 h.p. De Dion cars. With the exception of the 10 h.p. the 1904 types had band brakes on the back wheel hubs, and secondary wheel shaft, of which the present one, Fig. 38, is a modification.

CHAPTER IV.

CARE OF THE ENGINE AND CAR.

THE ENGINE.

1.—The Cylinder.

Where possible the injection of a little petrol over the inlet valve, at the same time pressing the plunger which displaces that valve from its seat, will usually be found to facilitate starting, and make the operating of the starting handle a lighter task. Through the same means a larger quantity occasionally injected will—as before described---cleanse the walls of the cylinder and improve the bearing of the piston rings against the cylinder walls, but it is well when doing so, to revolve the crank shaft rapidly, after making certain that the current is "off."

Occasionally, especially if too much lubricating oil has been used, it is advisable to detach the cylinder and remove the sooty deposit inside the combustion chamber, also to thoroughly clean the piston rings with a tooth brush dipped in petrol to prevent all chance of their sticking. The combustion chamber can be scraped with a knife, and afterwards well cleansed with petrol. The operator should be very careful not to let the scrapings drop into the crank chamber. In case misfires take place, not only will the valves be covered with a sooty deposit, but the top of the piston and combustion chamber will suffer in the same manner, and therefore will require more frequent cleaning than when the engine is running perfectly. To remove the cylinder it is necessary to let the water out of the tank. This is done by removing the plug at the bottom of the pump, next all the water pipe connections running to the water jackets should be carefully disconnected, the inlet pipe, dome, etc., on the engine removed, the four nuts securing the cylinder to the crank chamber unscrewed, and then the cylinder can be lifted off, care being taken to avoid any side pull while doing so.

2.—The Valves.

The induction valve should occasionally be taken out and the head and seat carefully cleaned with petrol or paraffin. The same should be poured on top of the exhaust valve, and a screw driver used to turn it round and round, so as to clean the surface of the valve against the seating. If the valve becomes pitted, grinding will be necessary. The motorist can do this fairly well by making a mixture of flour emery and thin machine oil, smearing the valve seat, and then turning the valve round and round, until both the valve's face and the seating become bright and smooth. The entrance to the cylinder should meanwhile be carefully plugged up with cotton wool, and after the operation is over all the emery should be wiped and washed out for if many particles get into the cylinder damage to the walls will result.

The exhaust valve must be ground in position in the valve chamber, by turning it under pressure with a screwdriver, or, if possible, a brace and bit, fitted into a slot at the top of the valve. It should be twisted to right and left alternately, a moderate amount of pressure being exerted. The valve should be lifted frequently and placed in a fresh position, and the operation continued, the object of this being to allow the emery and oil to get on the valve surface, and prevent the grinding taking place in the one spot. This method also applies to the inlet valve, which, however, may be dealt with more easily.

To test the grinding of a valve, clean off the emery and oil from valve and seating, place the valve on its seating and turn it whilst exerting some pressure on it. If properly ground it should show a well-defined band round the edge, showing the point where the two surfaces have been in contact.

3.—The Ignition and Contact Breaker.

The method of adjusting this part of the engine's mechanism is dealt with fully in Chap. VI. Repairs and Adjustments.

4.—Water Circulation.

It is all important that this should be in good order. In the first place, never pour water into the tank except through a funnel fitted with a strainer to catch any dirt particles which might otherwise get through into the pipes and stop them up, or interfere with the free working of the pump. Except the 6 h.p., all the 1904 and later model cars have separate strainers in the water inlet openings. In districts where the water is hard, it is advisable to fill the tank with rain water.

If there is any doubt as to the water circulating properly, one can tell easily by seeing if all the water pipes are of an equal temperature. Needless to say, if the water circulation is not right the engine will overheat, and the engine begin to run badly, and will finally stop, through the lubricating oil being burnt up. It may also cause the cylinder to become warped. As a rule, if the pump is opened and cleaned out, the trouble will cease. It will be well for the beginner to get himself used to the normal condition of heat at the cylinder jacket, so as to be able to tell by the touch when the engine has become overheated. The accompanying smell, too, is generally a reliable index, but the best test of all is to let a drop of liquid fall on the top of the combustion chamber. If it gradually evaporates, the engine is not over-heated, if it frizzles and rapidly evaporates, however, the heat has reached a stage when it is dangerous to proceed until the engine has cooled. Under such conditions, filling up the tank with cold water without waiting to let the cylinder cool may split the water jacket.

The tank should be kept replenished regularly, and the water should never be allowed to get low. Needless to say, continued hill-climbing, or continuous driving on low gear, will result in the water being used up more quickly than under normal conditions.

If the water has all been run off and the tank been refilled, it will be found that after the engine has started the level in the tank will have sunk. It is, therefore, advisable to pour in more water as soon as the engine is running.

5.—Burst Pipes.

In frosty weather unless the car is kept in a heated coach-house, the water may freeze in the pipes, and also in the water-jacket of the cylinder, or in the radiator pipes, and so burst them. It is, therefore, a wise precaution to run the water off every night in winter time, making sure that every part of the water circulation system is drained.

Where, however, such is inconvenient the freezing difficulty may be overcome by adding about 25 per cent. of commercial glycerine (costing per gallon 7s. 6d.) to the circulation water. A more frequent changing of the water than under normal conditions will then be advisable. With certain qualities of water the mixing with glycerine will entail the occasional use of washing soda as a solvent of the grease which would in time restrict the free circulation of the water.

6.—The Pump.

From time to time it will be found that the water pump will leak at the gland nut. It will then be necessary to tighten the nut. After continued tightening of the nut it will become necessary to renew the circular lamp wick packing, when at the same time the opportunity should be taken to thoroughly cleanse the pump and the circulation system generally.

It may also happen that after long usage the pump spindle or its bearings will have become much worn, and the bearings have become oval. It will then be necessary to renew the bearings and replace the spindle with a new one. Merely re-packing the gland will not serve. As regards packing the gland the soft wick should be well tallowed before being inserted in the stuffing box (gland hole).

7.—The Brakes.

No part of the car requires more systematically observing than the brakes and their mechanism. To facilitate the user the De Dion brake gear has been designed on simple and practical lines, and may be adjusted in a few minutes. A possible temporary cause of trouble is the presence of much oil on the drums. Before starting a journey the user should test his brakes, and note that the joints and coupling ends have been properly lubricated. Petrol applied by a brush will be found useful for removing oil from the surface of the brake blocks.

8.—The Bearings.

The axle bearings should be examined from time to time, to see if they are sufficiently adjusted. For the purpose it will be necessary to lift the wheels off the ground by means of a small jack.

This periodical adjustment of the bearings of the road wheels is very essential. By catching the upper part of the wheel and shaking it vigorously to and fro, play at the bearing can be detected. The wheel being jacked up, the axle cap must be removed. The key should next be taken out of the adjusting collar or lock nut, and the collar screwed in until all shake disappears, but at the same time the wheel should revolve freely. After the wear has been taken up several times, it will be found that the shoulder on the axle prevents further adjustment; it now becomes necessary to put a new or thicker washer between the brake drum and the inner collar. On no account should the car be driven while the wheels are loose on their bearings.

Similar attention to the gear box and engine shaft bearings will be repaid.

9.-Lubrication of the Engine

The object of lubrication is to maintain a film of lubricant between all parts which have a rubbing contact, no matter how slight that friction may be; but the quantity must be proportioned to the speed at which the parts are moving. This is, perhaps, the most important consideration in connection with the care and running of a car, for the slightest neglect may result in serious and even permanent injury. Not only is the quantity important, but the quality must be good, *i.e.*, it must be of the right viscosity. This concerns more particularly the interior of the engine, where, owing to the great heat the lubricant becomes rapidly charred. The chief points for the user to note are that an adequate supply is maintained throughout the journey to all the bearings, more particularly in the crank chamber, and to use only the oil recommended by the makers. The importance of the latter rule may be gathered from a test which the makers of the De Dion cars recently made with one of their standard 12 h.p. engines. Coupled to a dynamo of 50 amp. at 150 volts the engine, ***while lubricated with the special De Dion oil*** on a 35 minutes' test, maintained its full capacity, but on substituting another lubricant the power fell off to an output of only 35 amps. at under 135 volts—a reduction of over 3⅔ electrical horse power.

It is also important to remember that when the engine is new, friction is temporarily greater, and consequently the oil is used up more quickly, and must be more frequently renewed for the first few hundred miles. It is necessary, therefore, to recharge the base chamber about every eighteen or twenty miles, and a very careful watch should be kept on the engine, for the oil may require renewing, even more frequently in exceptional cases. Many users fail to note the necessity of draining the dirty oil out after completing every 100 miles. One effect of non-compliance with this rule is to cause mis-firing through fouling of the sparking plug by the excess of oil which then finds its way above the piston into the combustion chamber. Another item of importance in this connection is the cleansing of the engine by washing out the crank case For the purpose some prefer stale petrol while others use paraffin. There is no greater merit in one than the other; probably of the two the paraffin has a more scouring action, but if it be used by pouring in above the piston, with a view to washing the cylinder walls it is advisable to first remove the sparking plug, in fact, its removal considerably facilitates the task, and by substituting a disused plug temporarily screwed in, the crank shaft may be revolved by hand, and the oil then allowed to drain out of the base chamber

A —Lubrication of the Single Cylinder Engines.

It is advisable when one of these engines is new to put in two measures of oil to start with, and to change it about every 18 to 20 miles, at the same time to keep a careful watch on the engine. After the car has ran some 1,000 miles a full charge given about every running hour or half hour will be sufficient. It is, however, better to pump in a half charge every half hour, than a full charge every hour; for thereby the amount in the base chamber is likely to remain more uniform in quantity, being neither too full at the outset nor practically empty at the close. The hour or half hour rule must not be interpreted too rigidly; in fact, it is impossible to fix an all-round rule on the point of frequency of charging; for it is obvious that under certain circumstances the oil will be consumed at a faster rate than at other times. For example, in severe hill-climbing running on the low gear, or before a strong wind, travelling slowly in traffic, or when the water circulation is defective and the engine overheats—the oil will be used up in a comparatively short distance.

If the engine commences to run sluggishly it is quite probable that a fresh charge of oil is needed. This want, too, sometimes makes itself felt by a certain irregularity in the working of the piston, and causes a noise, technically known as a "knock." It is similar to the noise caused by advancing the ignition lever too early, or when ascending a hill steep enough to slow the engine. It is hard to describe this, but the driver should be able to tell almost at once by the engine making an unusual sound, and should at once pump in a fresh charge, or portion of a charge. If overheating has taken place, which will be seen by the motor's laboured running, an injection of paraffin above the piston head will also prove of value, but it will be then necessary to drain out the base chamber.

Attention to the two following points will be found useful:—

Insufficient lubrication or the use of improper oil, overheating and friction generally go together, and are often indicated by a hammering noise technically known as a "knock."

Excessive lubrication is denoted by smoke through the exhaust pipe, and an unpleasant odour of burnt oil. Unless these two last symptoms are apparent the driver may always take it for granted that he is not over-lubricating his engine, and if he is a man of observation, this fact should enable him early to learn by experience when to pump in fresh oil, and the correct amount.

B.—Lubrication of the Two Cylinder Engine.

This is fitted with a special oil reservoir at the side of the engine. To charge the base chamber of the engine with oil, it is necessary to remove the air release valve plug (to be found on the top of case between the exhaust valve-lifters) and then pour in about half a pint of lubricating oil, thus making certain that the valve gearing is thoroughly lubricated (any excess will find its way into the bottom of the crank chamber). Next pour a similar quantity into the oil reservoir itself, and after waiting a few moments until the oil has had time to find its way through the pipes to the crank bearings and connecting rods ends, the engine may be started, the valve plug meanwhile having been replaced. As the oil finds its way to the well in the base chamber a pump forces it again into the reservoir, whence the circulation goes on as before.

While the engine is running the reservoir should be filled to within an inch of the top of the gauge fitted thereto, which is the only method of ensuring a correct supply to the motor. The supply will then last about 250 miles, though it is advisable to occasionally note the height of the oil in the gauge, and it is well to make it a rule to keep the reservoir supplied to within the limit mentioned.

After every 500 miles traversed the oil should be drained off through the waste tap at the bottom of the crank chamber, and a new charge poured in. In addition it is recommended that after a prolonged run the motor be washed out with paraffin, giving ample time for a complete draining of the chamber before re-charging with fresh oil.

C.—Lubrication of the Four Cylinder Engine.

The oil reservoir for the four-cylinder De Dion engine forms part of the base chamber, and oil should be poured into this until it comes out of an overflow pipe, which is provided. Before starting the engine, when new, or after same has been washed out, it is necessary to remove the two air release plugs, which are placed between each pair of exhaust valve lifters, and pour about 1 pint of oil in each. This ensures the cam shaft being efficiently lubricated. The engine may then be started, as a pump fitted at the bottom of the base chamber forces the oil through all the bearings, thence through the crank shaft which is drilled, to the end of the connecting rods, some of the overflow from the latter being thrown into the cylinders. The oil falls into the receptacle at the bottom of the base chamber, but before it reaches the pump to be again forced through the bearings, it has to pass through a gauze filtering chamber, which can be easily cleansed or inspected. If the pressure of oil into the bearings becomes too great a relief valve comes into operation. (The object of this is described on page 23.)

10 —Lubrication of the Gears.

Fig 41 shows the simple mechanism used on the De Dion cars (excepting the smaller models) to ensure adequate and continuous lubrication of the gear shaft-bearings and the gears.

With the aid of the lettered key the principle of action will be readily grasped. It is, however, well to point out that in some of the later De Dion models, the gear box and differential case have an open passage way, and therefore only one oil pipe is necessary, but in the now obsolete models K, O, and W, they were divided and required a separate oil pipe for each of the two compartments.

An overflow hole will be found drilled one-third of the way from the base of the differential gear case, and the plug covering same should be removed before charging the chamber with oil. It is also necessary prior to starting to force in oil until it attains the required level —*i.e.*, commences to overflow at the above mentioned hole—and then to replace the cover or screwed plug. When running, a charge every two hours will generally be found to make good the deficiency from wastage. At the close of the run it is advisable to again remove the plug or cover over the overflow hole, and note how many charges of oil are required to make good the shortage. In that way the user can gauge if a charge every two hours on the road is sufficient to keep the supply normal. Where the gear case and differential box are separated by a division plate, it will be necessary to test each division, as in the models K, O, and W, in the same way.

It is well from time to time to wash out with paraffin the gear chamber simultaneously with the motor. Par-

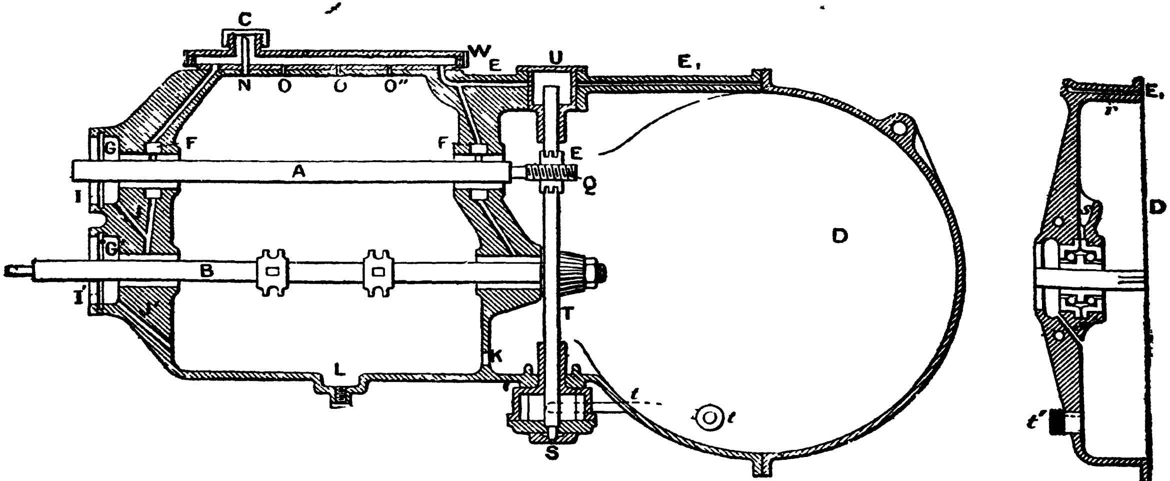


FIG. 41.—DIAGRAM SHOWING THE METHOD OF OILING THE GEARS AUTOMATICALLY.

A, primary gear shaft
B, secondary (hollow) gear shaft
C, oil inlet cap
D, differential gear case
E, pinion on oil pump shaft driven by Q
EE_1, oil channels leading from cup U
FF, oil channels round bushes
GG_1, space for oil overflowing from bearings
II_1, oil retaining rings
JJ_1 channels from GG_1
K, hole between gear and differential cases
L, outlet from gear case
NOO_1O_{11}, holes through which oil drops from channel W on to gear wheels
Q worm on end of shaft A driving pinion E on pump shaft
r oil channel on top of differential gear case
S oil pump
s oil cup to catch oil and lubricate ball bearings of differential gear
T, hollow oil pump shaft through which the oil is pumped to U.
t, pipe connecting differential gear case to pump.
t_1, connection for pipe t
U, cup into which oil is pumped from differential case and from which it flows into the channels
W, oil channel on top of gear case

ticles of grit, metal chippings and the like will be found present from time to time, particularly if the driver is not an adept in changing gears.

As concerns the smaller models the gear box is lubricated by a pump fitted to the dashboard. It is advisable to give a charge about every 50 miles, and the same precautions as regards testing the amount necessary to make good wastage hold good in their instance also. Frequent cleansing of the gear box is also of marked importance as concerns this car; as the whole of the transmission mechanism, clutches, as well as gear, is self-contained in the gear box. It is therefore to be commended that about every fourth time when the lubricating oil is being changed to fill up with paraffin, and then turn the starting handle for a minute. The paraffin should next be completely run off, and the usual full charge of lubricating oil substituted. This treatment also tends to keep the clutches in good order, and prevents them slipping.

Note.—As many of the older De Dion cars (having the engine fitted at the rear) are still running, it may be well to note that a special stick of solid lubricant is supplied by the firm for lubricating the differential gear Provision for this purpose was made by fixing a nickelled tube on the differential casing, and the makers prefer users to adopt the above special lubricants in place of any form of grease.

11.—Lubrication of the Axle Bearings, Hubs, and Cardan Joints.

A grease pump—Fig. 42, is provided with every De Dion-Bouton car. Every 200 miles the caps at the end of the hubs should be removed, the pump screwed in place, and the grease forced in until it finds its way out of the hubs on to the inside of the wheels. As a precaution it is advisable to remove the wheels occasionally, say every 1,000 miles (more frequently. if the hubs feel warm to the hand after running a short time), to make sure that the grease is finding its way over the whole surface of the bearings.

The illustration—Fig. 42—shows the style of grease pump, as fitted to the axle end for use. The dotted lines—B-B1—mark the position of the usual axle-cap, which has to be removed before placing the pump. When the screw handle M is actuated, it pushes the piston S against the grease which occupies the chamber G, and so forces it into the spaces round the axle.

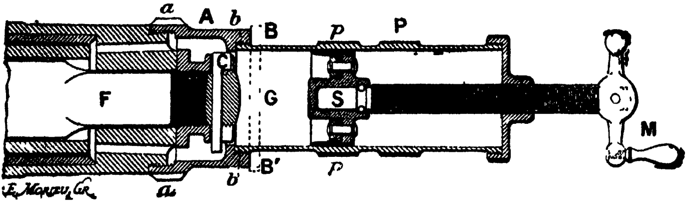


FIG. 42.– GREASE PUMP SUPPLIED WITH DE DION CARS.

The back hubs of all the later model De Dion cars require a second lubrication, besides the method described. The second is obtained by using a special fitting supplied with the grease pump whereby the bearings of the inner shaft and thrust bearings are similarly to be lubricated.

The cardans or axle-joints are covered by sheaths filled with grease. If there be doubt lest the grease has not penetrated thoroughly through the hole in the joint sleeve, it is advisable to remove the joint covers and pack the joints with grease. For ordinary purposes, however, the simplest method is to fill up by using a grease syringe. It is well to remove the metal sleeves over the joints after every 1,000 miles use, and then to examine the axle, cardans, and running gear generally, afterwards re-packing the joints with grease.

To dismount the cardan joints.—Push by means of a suitable punch the little spring-held pin which holds each joint sleeve until the latter can slide over or off the jaw. When this sleeve is drawn off, the cross head of the cardan axle with its two bronze squares can be drawn out of the large slot in the jaw, and then the other end may be drawn from the corresponding jaw without withdrawing the sleeve off that end. Having withdrawn the cardan axle, the differential portion with its jaw and sleeve can be withdrawn from the differential, and, after taking off the hub cap and moving the key and "castle" nut on the axle end, the cardan road wheel axle with its jaw can be withdrawn from the hollow axle. It should be noted that there is a long coil spring with plunger in the road wheel axle which presses against the cardan axle to take up the end play due to the movement of the chassis. The grease cups should be frequently refilled with grease, but care must be taken that the spring-catch holds the cup in place. This may be tested by gently attempting to turn the lubricator cup in the reverse direction. As regards such parts about the car where grease cups are not fitted, it may be taken that a good quality fluid lubricant is to be used. Generally speaking, an all round lubricating is advisable after a day's run—or say, per 100 miles.

Summary of Parts to be kept Lubricated.

To be Oiled.

The Engine.
The Gear Box.
The Sliding Rod of do.
Levers and coupling rods of steering gear.
Distance rod and steering bar.
Axle for starting handle.
Brake joints.

To be Greased.

Box containing worm and segment of steering gear.
Vertical spindles of steering heads.
Road wheel and hubs.
Road wheel axles.
Cardan joints of do.

12.—Nuts and Bolts.

It will save much inconvenience and a risk, if the motorist, before going for a run, will spend a few moments glancing over the various nuts and bolts, so as to make sure that they are secure. The locking pins, too, should be examined, and, if they are missing, new ones should be fitted. This attention is particularly necessary as regards the steering gear, for if a bolt should drop out while the car is running, and the steering become inoperative, an accident is very likely to result. All important nuts are pinned, but regular supervision will be well repaid.

13—Tyres.

The advice generally given is to pump hard, and undoubtedly that is the safest course, for a soft tyre is liable to puncture on the rim, and will also wear much more rapidly through excessive flexion at the side, than one pumped hard. At the same time, there is a happy medium. If the tyres are pumped board hard they will shake both the car and rider terribly. The better practice is to have the tyres pumped to such an extent that when the car has got its load on board, the depression where they touch the ground is just appreciable.

Pneumatic tyres are bound to get gashed more or less by the stones on the road, and a burst tyre is nearly always the result of wet having penetrated through these gashes, and by degrees rotting the fabric. For this reason, the tyres should be glanced over after every lengthy run, and if it is found that the surface of the rubber has been gashed, the cut should be carefully cleansed, preferably with benzine or petrol.

The gash should then be quickly repaired by vulcanising patch or the use of some suitable stopping. The car should not be driven for about 12 hours, so as to give the preparation ample time to set.

14.—Cleaning.

The car can be hosed down as in the case of a carriage, and then dried with sponges and chamois cloths, care being taken not to dull the varnish. As regards the engine, the best possible cleansing agency is waste petrol. A good strong paint brush can be used for the purpose of applying it. For working at the car after dark it is well to have a small electric lamp, such as is supplied by any factor, or else one of the special safety lamps to be obtained from motor sundries dealers.

CHAPTER V.

HOW TO DRIVE.

Preparing to Start.

See that there is sufficient petrol in the tank. This may be ascertained by putting a clean wooden rod through the aperture in the top of the tank, or better still by using one of the celluloid gauges supplied by Messrs. Bluemel Bros., Wolston, near Coventry. Next see that your water tank is full, that the crank chamber has received a full measure of oil, the remains of the old charge (if any) having first been allowed to run off, and that there is sufficient in the gear box. Every bearing too should be carefully lubricated, and every bolt and nut looked over. Having satisfied yourself that the car is in running order, the next procedure is to turn on the cock under the petrol tank, adjust the carburetter lever to give the richest mixture, depress the plunger in the carburetter float chamber until the petrol overflows, put the switch into position, see that the clutch is out of gear, and put the hand brake hard on. To forget these points will result in the car not starting, or stopping after a brief interval.

How to Start.

Next retard the sparking advance lever as far as possible, so as to prevent the risk of a back fire. It sometimes happens that the engine will not start freely with the ignition retarded to the fullest. In such a case the lever should be advanced very slightly until the best position has been found by experiment, bearing in mind always that the further it is advanced the greater will be the risk of a back fire.

The carburation lever is the next that requires attention. Seeing that the piston can only be made to travel at a comparatively slow rate when operated by the starting handle, it is necessary to put the carburation lever in such a position that nearly the entire volume of air passes round the spraying nipple. By consulting the drawing of the carburetter, which appears in Chapter II. it will be seen that to attain this end the lever should be in the middle position.

This remark applies strictly only to the older pattern carburetters and the one used on the 1905 6 h.p. model, but as regards the later carburetters it should be moved to the limit in order to obtain the maximum proportion of air over spray. About a quarter of a circle is the total movement of the lever. Sometimes it is necessary to flood the carburetter by pushing the plunger home two or three times. With the starting handle at the lowest point push it home until it grips; then give it a quick, sharp pull *upwards*, either disconnecting or letting the handle go as the highest point is reached, so as to avoid the risk of a backfire should such occur. There is a knack in the sharp pull essential for the starting of a De Dion engine. It should be practised with the ignition turned off, as there is then no fear of a backfire. To turn the handle slowly and steadily, or to wind it round several turns may result in a backfire. The handle should always be pulled *upwards*, never pushed *downwards*, and it is advisable to place the thumb on the same side of handle as the fingers.

If there is difficulty in starting; in the case of a single cylinder car, open the inlet valve by holding the left hand on the little plunger, or release compression knob fixed over the valve, and with the other hand turn the starting handle round several times. This reduces the compression and sucks in a certain amount of mixture. If the engine is still refractory remove the little plunger, squirt petrol from an oil can on top of the valve, and then replacing the plunger, depress the valve so as to admit the petrol to the combustion chamber. [Under "Repairs and Adjustments," Chapter VI., the difficulties of starting are further dealt with.]

The two and four cylinder as well as some of the later one cylinder cars are provided with a compression release arrangement to facilitate starting. This is actuated by a rod projecting through the frame under the bonnet in front of the car. It is then held in position by a stop while the handle is being turned. When the motor starts return the rod to its usual position.

Having started the engine, the ignition might be slightly advanced, and the carburation lever moved to allow more air to pass over the spray. The reason for this is that the engine is now running more quickly, and therefore more air is needed to dilute the mixture, which might otherwise be too rich.

Taking it for granted that the engine is now running, the next step is to operate the lever of the valve regulator, so as to reduce the speed of the engine while the driver takes his seat. When ready to proceed. move the exhaust valve closer to the former position to the right of the quadrant, and press the corresponding foot pedal, which similarly controls the same regulator.

[Note.—In 1905, models 8 h.p. and upwards, the throttle lever is placed on the left side of the steering column, and is *drawn back* to operate the *throttle.*]

Next release the hand brake, advance the ignition lever to about a medium position and raising the pedal (controlling the exhaust regulator) to enable the engine's speed to be increased, proceed to start always on the lowest speed gear, allowing the clutch to slip a little at first so as to enable the engine to take up the load by degrees. As the pace increases draw back the carburation lever to the air position.

This method of starting more particularly applies to the 6 h.p. car, which is fitted with expanding clutches, as well as most of the 1903 and 1904 models, the gear being affected by the varying movements of their respective clutches. In the case of all the other De Dion 1905 models—which are fitted with a sliding type of gear and an external clutch---the *modus operandi* differs in that the change speed lever must be first moved to enable the low speed gear to become meshed, before letting in the disc clutch. The action in that instance is identical with that used in almost all modern cars, the gears being first meshed and the clutch gently "let home."

How to Change Gears.

A.—The Expanding Clutch System.

There is nothing easier or more simple than changing gear in the case of the expanding clutch type, which is fitted to the 6 and 8 h.p. cars, because it is impossible for the driver to damage the pinions, seeing that they are always in mesh. At the same time there are certain precautions which it is necessary to adopt.

In changing on to the low speed from the neutral when the car is at rest, the engine should be run at about 1,000 revs. per minute, and then the gear lever should be very slowly and gently operated, so that the expanding clutch will slip at first and the drive be consequently taken up gradually. If the gear lever is pushed right over at once the car will start with a jump, and the strain to the engine and transmission system will be considerable. In changing from the second speed to the high speed the lever should be operated quickly, as otherwise the car will slow so much that the engine may not be able to take up the drive, and will commence to thump. At the same time it is well not to force the lever right home at once—*i.e.*, so that the clutch at once grips positively. This also has a tendency to slow the engine and prevent it picking up easily on the higher speed. In other words, the driver must adopt the happy mean, the movement must be fast and definite up to the point that the clutch begins to come into engagement, but the remainder of the movement should be gradual, so that at first there will be a slight slip which will enable the engine to maintain its speed while the car is gaining pace.

In changing down the rule is somewhat different. If the car is ascending a steep hill and slows up gradually until the engine begins to labour, the change should be made as rapidly as possible, the gear lever being forced right home. The reason for this is evident. By the time the change is being effected the speed of the car will have dropped to about that of the next gear, and, therefore, the engine will not be slowed even though the clutch comes into positive engagement at once. If for any reason, however, the driver is changing on to a lower speed when on the level, or on a gentle incline, the pace of the engine should be slowed a little, and the gear lever operated gradually, because in this case the pace of the car would probably be higher than the gear on to which he wishes to change at the moment when the change is effected, and, consequently, if the lever was forced home definitely, it would have the effect of checking the speed of the car with a sudden strain.

Briefly put, the movements may be thus summarised:—1st, the clutch operated by pulling the handle towards the driver engages the middle gear only; 2nd, the clutch operated by the forward movement engages the high, low, and reverse; normally it operates the high gear; 3rd, to obtain the low, the right pedal must be fully depressed and the clutch lever moved forward; 4th, to obtain the reverse a lever at the side of the car must be moved forward until the catch engages in the notch in the quadrant, and then the clutch handle similarly moved forward.

B.—The Sliding Pinion System.

All De Dion cars, excepting the 6 and 8 h.p. models, are now fitted with the sliding form of gear—*i.e.*, in which the pinions are slid into mesh, and to avoid the edges of the teeth being brought into engagement the driver will have to carefully study the system of changing. In starting from the neutral he should begin by withdrawing the clutch by means of the pedal, and then carefully feel his way into the low speed. If he has difficulty, he should let the clutch home gently and try again. In changing from the low to the second, or from the second to the third, the clutch should be taken out quickly and decisively, and at the very same moment the gear lever should be operated quickly and similarly without hesitancy. If the teeth grind, do not continue the attempt, but drop back again on to the lower speed, let the clutch engage for a moment, and then repeat the operation. In changing *down* the clutch need not be withdrawn so sharply, and the gear lever need not be operated so decisively—the driver feeling his way until the teeth gently slide into mesh.

It is a great mistake when climbing a hill to delay changing until the car is absolutely labouring; it strains the mechanism and does not facilitate the car's progress. Similarly, when ascending the hill, and the gradient begins to moderate, the driver should not change too early, under the mistaken impression that he will ascend the hill faster, but should make quite certain that the car will take its drive on the higher gear before he attempts to make the change.

Summary of Movements Prior to Starting.

The several operations may be thus summarised:

1. Inspect oil, water and petrol tanks.
2. See that the petrol reaches carburetter.
3. Make sure that the base chamber and gear case are fully charged with oil.
4. Regulate the carburation lever as experience will show best.
5. Put switch lever to M. or "On."
6. See that the motor is out of gear and the hand brake hard on.
7. See that exhaust valve regulator lever is to the right.

The engine is now ready for starting and only needs an impulse. The switch has closed up one gap in the electric circuit, but for a spark to be produced at the plug the contact breaker has to act, and the piston has to draw in a charge of explosive mixture.

These operations are to be effected thus:

8. Put sparking lever in retarded position.
9. Turn starting handle.
10. Manipulate spark and carburation levers so as to get engine running at fast pace.
11. Take hand brake out of action.
12. Throw in low gear, and prepare to apply clutch gently.

On Driving.

Proceed very slowly and cautiously at first on the low speed, and practice stopping, starting, reversing, sharp turns, etc. Having acquired more confidence, a change may be made through the next gear to the top speed. A slow pace should be maintained at first, by using the regulator pedal and retarding the ignition.

Practice and attention to one's task, together with modicum of sweet reasonableness as regards the righ of other users of the road are the chief items to cultivate. Behaviour on the road or elsewhere is a fitting test of man's claim to the respect of his neighbours, and th motorist is no exception. It is not a mark of exper ness to take unnecessary risks, or to do anything calculated to make the onlooker consider that one's actio was a danger to another. Hence in traffic it is better to stick to the medium gear, and control the car entirely by the exhaust regulator pedal, with the ignition not too much advanced. No rule as to the actual position of the control lever can be made common to all cars; the user must make himself acquainted with the features and purpose of each, but the following hints or points to remember will indicate at least the line such a study should take to be of practical benefit.

Points to Remember.

Economy in petrol, power of the engine, and cleanliness as regards the plugs, pistons, and valves, depend upon the correct manipulation of the carburation lever, the ignition lever and the pedal for regulating the lift of the exhaust valve. In this connection there are a few fundamental principles which should be borne in mind.

I. It is bad practice to make a habit of retarding the ignition excessively. This has the effect of firing the charge so late in the stroke that the flame escapes through the exhaust valve, thus causing excessive heat and injuring the valve. On the other hand, the novice often labours under the mistake that if he wants to increase his speed, he need only advance the sparking lever to do so. This is to a certain extent true when the work is light, as on the level, but when the work becomes heavy, and the engine slows somewhat, if the sparking is advanced to the fullest extent, it will result in the explosion occurring before the piston has quite reached the highest point, and consequently power will be lost, and a back pressure will be caused on the piston. This will produce what is commonly known as a "knock," and is injurious to the bearings. The driver, therefore, must remember to operate his sparking lever according to circumstances.

II. As regards the carburation, it must be remembered that on the speed of the engine depends the amount of suction, and consequently the flow of petrol. When the engine is running very fast the rush of air past the spraying nipple causes a large amount of petrol to be drawn through, while when the engine is running slowly the suction is reduced and with it the quantity of petrol, and it is consequently necessary to deflect more air over the spray to maintain the suction.

III. The depression of the exhaust valve regulator pedal prevents the full charge from escaping, and consequently a smaller charge is taken in at the next suction stroke and spirit is economised, though at the same time the maximum compression is secured. To get the best results, therefore, these three points must be borne in mind.

In the case of the single cylinder car, when the engine is travelling at its fastest pace, the carburation lever must be kept back as far as possible towards the steering standard, thus increasing the supply of pure air. In this position the knife-edge in the carburetter divides equally the stream of air, half going downwards and then upwards past the spraying nipple, and half going straight through the carburetter to be mixed with the crude vapour in the induction pipe. If the engine slows, as for example, on a steep hill, or when running very slowly through traffic, the lever should be so altered as to reduce the aperture through which the pure air reaches the inlet pipe and increase the aperture through which the air goes downwards, and then up past the spraying nipple. Immediately the engine quickens again more air should be admitted by moving the lever back towards its former position.

To put it briefly, the carburation lever should be altered according to the speed at which the engine is running, and it is better to err on the side of too much air than on the side of too much gas.

IV. As regards the ignition lever, the driver should (except when starting) avoid as far as possible retarding the ignition beyond the medium position as it tends to cause burning of the exhaust valve head. For top speed the ignition must be advanced further.

The Exhaust Valve Regulator—Its Purpose—How to Use.

The object of this device, which is illustrated by Fig. 8, page 12, is to provide the driver with a simple means of controlling the engine and car by either pedal or hand-lever without too frequently altering the position of the ignition lever or affecting the change speed gear. The user, therefore, should study its purpose carefully.

It should be used as a throttle valve in order to regulate the quantity of mixture in proportion to the work to be done.

With the ignition lever somewhat advanced, and a comparatively strong mixture of gas and air, the beginner may naturally wonder how he is to check the pace of the car, or prevent the engine from racing without altering either of these levers, or at all events, without altering them to any great extent. It is here that the use of the exhaust valve regulator comes in. By depressing the pedal the volume of gas admitted to the combustion chamber is greatly reduced, consequently giving a weaker explosion; thus economising petrol, reducing the noise and keeping the engine comparatively cool. For example, when running at top speed down hill, or on the level, there is no need for a full charge. The exhaust valve regulator should therefore be operated and the driver use his own judgment, raising his foot when he feels the pace of the car slacken. If he wants to run along at a steady fifteen miles an hour the pedal may have to be depressed considerably, while if he wishes to run from 10 to 12 miles an hour (still on the high gear) he will have to depress it to the utmost, without, of course, applying the brake (the brake should never be applied when the engine is in gear), and at the same time retard the ignition somewhat, and again graduate the strength of the mixture to compensate for the reduced speed of the engine. This latter movement is not essential until the pace of the car has dropped very considerably. On the lower speeds the same rules apply. If the engine is running fast the carburation lever should be operated to give more pure air no matter what the gradient, and the regulator pedal depressed as required. If the speed of the engine drops, an increase of speed can be obtained in a moment by raising the foot. If a hill is approached the ignition should be at once slightly advanced, and the foot raised off the pedal until the driver can tell by ear if the speed of the engine is approaching its maximum. If the hill becomes so steep that the engine slows, the carburation lever should be gradually moved to get a richer mixture, while the ignition lever should be slightly retarded at the same time

In traffic, the regulator pedal should be held about half depressed. Then when occasion offers, by lifting the foot the car's pace will be accelerated sufficiently to quickly pass other vehicles.

When the engine is running free (the car being at rest) the regulator should be solely operated by means of the hand lever on the standard, which, similarly operates the exhaust valve regulator. It should always be borne in mind that the less the exhaust valve is allowed to open the weaker will be the force of the explosion, and consequently the less will be the noise. In fact, the driver should make the fullest possible use of the exhaust valve regulator, especially when passing restive horses. It should be understood that, no matter how much it is operated, it does not wholly close the valve; provided, of course, that it has been correctly adjusted. It really acts as a governor; and has the effect of economising petrol, reducing noise, keeping the engine cool, and providing the driver with an instantaneous means of varying the speed of the car.

The hand lever control of the regulator should only be used when the driver intends to leave the engine running, or preparatory to his leaving the car; but for other purposes the pedal alone should be used to operate it. For this purpose the hand lever (where an independent one—*e.g.*, on the 6 h.p. car—is fitted) should be moved on starting completely to the right, and kept there, for if only moved to the middle position much of the efficiency of the pedal control would be sacrificed.

In brief, when the lever is at the right, the pedal has full power over the exhaust; but when the lever is at the left the pedal has no power over the exhaust, and simply works the brake on the differential.

The hand lever is, therefore, only to be employed when the car is stationary or when it is intended to run the motor at a fixed speed for a considerable time.

For all slackening of speed without taking the engine out of gear the regulator is to be used, but the brake should not be applied with the engine in gear.

When one desires to stop the car completely, it is necessary to throw the engine out of gear and apply the pedal brake.

In coming to a halt when it is *not* desired to stop the engine, the exhaust lever should be moved to the left thus slowing down the motor; the ignition lever should also be in the retarded position.

Briefly, the whole secret of correct driving may be summed up as follows:—Use the best possible mixture, but, above all, make sure that it is not too rich, explode it at the best time, and only allow into the combustion chamber what is absolutely necessary for the work to be done.

Side-Slip—How to Avoid the Peril.

A side-slip is one of the most dangerous enemies that the motorist has to guard against. There would seem to be no law governing side-slip, and at times no amount of skill in driving will entirely prevent it, though the danger may be modified to an extent.

The class of mud on which a motor car slips is exactly the same as in the case of a bicycle, and consequently the driver who is also a cyclist will be in a better position to judge than another. Briefly, if the mud is thick and half dried, or if there is a thin film of grease over setts or wood paving, or if the road surface is composed of a slimy quality of limestone, the driver must exercise great caution. Frozen roads are, as a rule, safe. A sheet of ice, however, must be traversed cautiously, but if the surface has sufficiently thawed to become wet, it will be even more treacherous than the worst class ot mud.

The best safeguard against side-slipping is to travel slowly at a steady, uniform pace. A sudden, violent, application of the brake, a sharp turn of the steering wheel or a sudden acceleration of pace, may set up slipping. The driver should, therefore try to run his engine at an absolutely uniform speed, using the valve regulator for this purpose, and should avoid travelling at a pace which would necessitate a strong application of the brake should an obstruction suddenly block the road. The action of a car in grease is often deceptive. The driver may find he can maintain a fast pace without any sign of side-slip, but he is almost helpless should the need arise for a sudden stop. If he puts the brake on suddenly, the car may swing right round. A swerve or an attempt to take a corner quickly, will also have the same effect.

When a side-slip does occur, the driver should declutch the engine on the moment. If he has applied his brakes, he should let them off again, and in order to right the car he should turn the steering wheel very slightly to the side to which the car has slipped, and almost instantly swing it round again in the direction in which he wishes to go. The object of this is to enable the front wheels to get sufficient bite on the road to make steering possible. If the wheel is violently turned in the opposite direction to the slip, the car is most likely to continue slipping, and perhaps will turn completely round. Should the latter happen, the driver must at once let his clutch in again, when the front wheels will probably again grip.

It may, perhaps, seem that driving on a greasy road is exceedingly dangerous To the experienced driver, however, it is not so. He quickly learns the speed at which he can travel with safety, and the amount to which the brakes can be applied without causing side-slip. Should the car swing round, it will not sustain any damage unless it strikes some obstruction or glides into a ditch.

On Hills and When Taking Corners.

When about to climb a hill, increase the speed of the car, so as to get a good rush at it. As the pace decreases retard the ignition slightly, and also move the carburation lever gradually forward so as to compensate for the decreased suction caused by the falling off in the speed of the engine. The sparking lever, however, should not be retarded beyond the medium position, and the mixture should not be unduly enriched or fouling will result. If the car still slows, and the engine begins to labour, a change must be made on to the low gear, whereupon the carburation lever should be moved back towards the previous position, and the ignition lever should be manipulated according to circumstances. If the hill is not very steep, the medium position will probably suit. If, however, it is a steep hill, and the full power of the engine is required it will have to be still further advanced. If the hill is so steep that the engine begins to slow, the ignition lever should be retarded again to about the previous position, and the mixture be again enriched.

While ascending the hill run on the high gear until the pace has dropped to that of the second gear, then change on to the first gear, if the grade requires. If, however, the engine is manifestly labouring, it is better not to wait until the pace has dropped to the lower gear limit. To prevent the strain likely to follow a sudden change under such circumstances however, let the gear lever remain in the neutral position momentarily until the pace of the car has slackened to about the next gear's maximum; then change rapidly and the drive will be taken up without any jar. When driving on the first speed, it is essential that the engine should not be allowed to race, as this will quickly rack it to pieces. The racing of the engine can be quickly detected by the vibration of the car and the increased noise caused.

When descending a hill it is a good plan to let the engine run "idly," the sparking being slightly retarded and the exhaust valve regulator pedal depressed. It will cool the engine. The driver, however, should be quite sure that his brakes are in a thoroughly dependable state. If the hill happens to be an abnormally steep one, he should never let his car attain a fast speed.

There is another method of retarding the pace, which also cools the engine, that is to switch off the current, slip in the high speed, and let the car run against the piston's compression. Needless to say, the switch must be put on before the bottom of the hill is reached if the car has lost its momentum, or the engine will have to be re-started with the starting handle.

When approaching a sharp corner, reduce the pace, and as the bend is reached put the engine out of gear. The moment the car straightens after taking the corner, slip the gear into operation again. If the curve or the corner be comparatively slight, however, it can safely be taken with the engine in gear.

On Checking the Pace and Stopping.

To check the speed of the car, operate the valve regulator by means of the foot pedal, but taking care not to press hard enough on same to apply the brake. If a still slower pace is required, retard the ignition, and, if this is not sufficient, change on to the low speed when, with pedal depressed and ignition retarded, the car will travel at five or six miles an hour. If, however, it is desired to travel at a walking pace as in congested traffic, let the clutch slip slightly. This is done by driving with the clutch faces only partially in grip. Doing so, of course, causes a certain amount of wear, but not to an appreciable extent. It should not, however, be made a constant practice. On no account should the brakes be applied when the engine is in gear, except when descending a steep hill, or when the brakes of themselves are not sufficient to keep the car in hand. It is injurious to have the engine working against the brakes. On ordinary hills the clutch should be put out of operation, and the car held in check altogether by the brakes.

Whenever the steering of the car tends to become erratic, the speed should be decreased at once by disengaging the gear and applying the brake. It is very difficult for a novice and very dangerous to try to recover control of the steering without slowing the car first.

To stop the car altogether, under all circumstances the engine should be thrown out of gear, the valve regulator operated, the brakes put on, and the sparking retarded. This fourfold operation is exceedingly easy to perform when one has time to think, but the beginner must bear in mind that should an emergency arise when he is driving fast, there is but a fraction of a second for thinking, and the slightest pause may cause a bad accident. For this reason, he should drive the car slowly until the operation of stopping it can be performed instinctively. Practice will result in the hands and feet acting simultaneously; but until this ability is attained, a beginner is very apt in an emergency to apply his brake and stop the car without putting the engine out of gear. This causes exceptional strain both to the engine and gear, and may result in serious trouble. If the car is to be left unattended, it is advisable to stop the engine also, partly, to comply with the spirit of the law, but chiefly to prevent possible mischief at the hands of passers-by, though it may not exonerate the driver if the police find the car unattended. The engine may be stopped by retarding the sparking, putting the gear lever into the free position, and switching off the electric current. Do not stop the engine with the valve regulator in action, as this will cause a bad mixture to remain in the cylinder. and prevent the engine re-starting easily.

Note.—Users of the larger De Dion cars may find some of the foregoing instructions not pertinent to their cars. So far as mere handling of the engine and control levers is concerned the data will apply. but as regards driving on the road, one of the best features of the multi-cylinder car is that it provides the driver with a flexible engine, and spares him the necessity of manipulating individual levers under normal conditions. The driving is almost altogether done on the top gear, the pace being varied by the sensitive throttle control and the exhaust valve regulator, as in the case of the smaller cars, but the additional number of cylinders more evenly distributes the "turning effort," as it is termed. at the crank shaft. and obviates any nursing of the engine to get the desired result.

CHAPTER VI.

REPAIRS AND ADJUSTMENTS.

On De Dion cars very few mechanical adjustments, under ordinary circumstances, become necessary. The troubles are mostly of a minor sort, and may be largely prevented by attention to such items as will be here treated of. The engine and gears will run some thousands of miles without requiring a renewal, but some of the minor parts will from time to time require attention.

Failure to fire the gas caused by some electrical defect is responsible for most temporary stoppages, and therefore to simplify the user's task these features have been sub-divided under the following heads·

1. The Wiring,
2. The Contact Breaker,
3. The Sparking Plug,
4. The Coil,
5. The Battery or Magneto (if the latter is fitted)

1.—The Wiring.

The vibration incidental to road usage is apt to loosen the connections that exist for the purpose of conveying the electric current along its proper circuit. The effect of this is to set up a short circuiting of the current in the case of a loose connection, or even to cause its failure altogether if any of the connections are broken It may also happen through the presence of grease or dirt, but, in particular, of water or moisture, on any portion of the exposed surface of the wires. Begin, therefore, by examining all the connections to test if they are tight, especially those at the plug and contact breaker. Should any be loose, before tightening, detach same and clean the terminals with a knife blade, or with a piece of emery cloth. Then attach and test for a cure by starting the motor. Should the result not prove satisfactory, detach the high tension wire from the sparking plug, and with the switch on, hold the wire (taking care to grasp it in a well insulated part and preferably with gloves on) about ¼ inch from the end of the sparking plug. Then get some one to operate the starting handle and note the quality of the spark—which should be a series of bright flashes. If, however, no spark passes, it is an indication of a short circuit taking place in some portion of the wiring; but if only a feeble and "trickly" sort is produced, this is rather an indication of the dry battery or accumulator, as the case may be, having "run down." It will be necessary to test the one by an ampere meter, the other by a volt meter. Should the test show that such is the case, the battery may be discarded, or if an accumulator (storage battery) it must be recharged. Presuming that the battery shows over 3 amps., or the accumulator not less than 4 volts, the trouble will be elsewhere.

Supposing, however, no sparking takes place, next proceed to carefully examine the whole of the wiring on the car. This is not so formidable as would appear. Simply run the finger over each length of wire in turn, and at intervals gently pull same. Should a defect, indicated by an undue looseness at any part, reveal itself, examine closely to see if a fracture of the wire has there taken place. In that event the fracture must be repaired. To effect this, strip back the insulation at the point, and unwind the stranded wire for a small portion of its length, clean the ends, and with a pair of small nose pliers, twist the two sections together again. If a means of soldering be available it would be well to solder them at once, but on no account use the ordinary soldering fluid, for the corrosion that would afterwards be set up would prove fatal to the wire; resin only should be used. When the fracture has thus been repaired, again test the ignition in the above way, and if satisfactory, at once proceed to re-insulate the bared portion of the wire by cutting off the peeled ends, and bind with insulating tape, occasionally stopping to warm same by a pressure of the finger, and so cause the solution to firmly adhere.

To test a low tension wire for a short circuit or breakage, attach one wire of the voltmeter to the end of the wire to be tested, which must, of course, be in contact with one of the terminals of the battery. Then make momentary contact between the other wire of the voltmeter and the opposite pole of the battery. Note if the voltmeter gives a similar reading to the one shown, on testing the battery itself. If no voltage is shown the wire is broken, but if a diminished one, then a short circuit or leakage is taking place. An excellent method of treating the wiring is to run all wires, especially any that are led along the metal parts of the car, in rubber tubing, or carry them on porcelain insulators; the result is well worth the little trouble involved.

The switch should also not be neglected; occasionally it fails altogether, but sometimes the fault is that it fails to cut off the current, and so permits the battery to be "run down."

To test for trouble at the switch, merely join the wires by a temporary connection, having first detached them from the switch. For the second cause test at the contact breaker, or sparking plug, if the circuit is closed (though the switch be in the off position) on operating the starting handle sparking will take place. Remedy, pending repairs to the switch, disconnect one of the wires while the car is not required.

2.—The Contact Breaker.

In Chapter III. the forms of contact breaker used on the De Dion cars were fully described. The type illustrated by Fig. 23, was that used on the single cylinder cars up to 1905 (the very earliest models excepted). Fig. 24 (page 54) shows the present type fitted to the 6, 8, and 9 h.p. single cylinder, and the 15 and 24 h.p. four-cylinder cars, while Fig. 25, page 56, illustrates that used on the two cylinder models To prevent confusion each will be treated of separately.

A.—The Single-Cylinder Contact Breaker (old style).

It will sometimes be found necessary to examine the white metal tipped screw and the contact blade on the contact breaker. Most of the troubles on this score are due to the relations of both becoming irregular, either through dirt (usually carbonised oil), getting on the points of contact, or an uneven wearing of the points themselves, which most occurs after considerable usage. The remedy in both cases is re-adjustment, but in either instance it will be well to first clean the dirty or pitted portion, and this is best done by scraping the contact point with the blade of a penknife, rubbing with fine emery cloth, or—in the case of the blade—tapping with a light paned hammer the irregular surface, the blade being held on an anvil or similar flat surface. When neatly done, either of these methods is better than using a file, as the surface to be cleaned being so small, it is almost impossible to avoid filing it unequally, which this causes an imperfect contact when the points are again brought together. After cleaning and replacing, the adjustment is effected by turning the engine round until the wedge on the contact blade drops into the slot in the cam, as shown in Fig. 23. It is *most important* that the wedge should occupy the position shown, and no satisfactory adjustment is possible unless such is the case, even if it be necessary to slightly bend the blade—which is best done just above the hole.

The contact screw must next be so adjusted that when the blade is in its correct position in the cam notch, the screw will have just sufficient pressure on the blade to raise it about 1-50th of an inch from its natural position. A simple method to follow is to touch with one finger the back of the blade opposite the points of contact while adjusting the screw with the others. The exact moment the two points come into contact can then be located. To get the correct adjustment, the screw will require about one-tenth of a turn more, but the final adjusting is best done when the motor is running, as the variation in the firing and response of same to the several positions of the ignition lever are then more easily seen. When engaged in adjusting the contact breaker, the user will find it an opportune moment to inspect the terminal connections at the contact breaker. The adjusting of the blade and screw is a matter for care, but with a little practice it becomes an easy task.

When fitting a new blade it sometimes happens—as before stated—that the wedge does not drop far enough in the notch in the cam. The method for dealing with this has already been described, but it is well to note the effect will be that it will take a very high speed of the starting handle to get the motor to start, and will require the ignition lever to be well advanced to maintain anything like a fair speed. That is due to the sluggish movement of the contact breaker at the moment the cam edge lifts it clear of the contact screw—breaking contact—it is called. It is essential that as sharp a rupture at the points be obtained, for it is only then that the spark is caused at the plug, and that firing can take place. Supposing, on the other hand, that the wedge piece falls too deeply into the notch a similar sluggishness of the rupture is caused, but its effects would be noticed when the ignition lever was advanced. The motor would start readily and fire correctly at low speed, but would mis-fire when the ignition lever was advanced, the cause being that the blade had not time to fall and make contact with the screw.

After adjusting the blade and screw make it a rule to test the firing of the charge with the contact breaker at both extremes of travel, taking care not to unduly prolong the test while the engine is "racing." A simple rule to adopt when mis-firing occurs is to—

(a.) Test the battery or accumulator.

(b.) Test if the contact points are clean—*i.e.*, not pitted by fusion or covered with carbonised oil or dirt.

(c.) Test the condition of the sparking plug—the points should not be more than the thickness of a stout visiting card apart.

(a). To test the battery use a volt or ammeter as directed under *Battery* (this Chap.).

(b). To test the contact points, the blade is best removed and examined, for its contact point is always the one to become pitted by fusion. When replacing, it is advisable to insert a washer between the blade and the screw head; it facilitates the degree of spring necessary to get good results as regards breaking of contact. As a superficial test, a stout visiting card or similar substance, having a glazed surface may be inserted between the contact points, and used as a file to cleanse them of oil, the wedge piece being at the same time in the cam slot. It is important to use no material of a porous nature, or likely to disintegrate while being used as a file, as if any particles become bedded between the points irregular contact will ensue, and itself cause mis-firing. Another method is to wash with a brush, previously dipped in petrol, the contact points while apart, taking care that the current has been first switched off, though as long as they are kept apart no harm can ensue.

(a) Single Cylinder Contact Breaker (old pattern.)

Very rarely it happens that with this form of contact breaker the blade becomes cracked, and later on will fracture. Rough treatment—*e.g.*, when bending or "setting" it for adjustment may cause such a failure, especially if the material be a trifle too hard.

A more likely cause of trouble is the loosening of the white metal rivet in its hole. That may be looked for when the solder at the back of the blade has dropped off. It is usually only sufficient to lightly re-rivet it, or, if preferred, to drop another blob of solder. The wedge piece riveted to the top of the blade also usually, after long usage, may become loose. If much worn, that is to say, if the once blunt edge has become rounded the wedge should either be renewed or a new blade (preferably the latter course) be substituted. The same applies to the cam. When the edge which meets the wedge piece becomes rounded it is well to replace the cam. Many cases of continued mis-firing on engines, with as long a life as the De Dion, are to be attributed to wear at the two parts mentioned. To guard against possible trouble, the user should always carry a spare blade previously fitted and tested. The same applies to the contact screw, which, though not subject to much fusing, gradually becomes worn at the tip.

The contact breaker plate or carrier after long usage becomes worn and loose on the boss about which it moves. This also may set up irregular firing, through the earthed or negative circuit being rendered intermittent, especially when the car is being subjected to vibration, or if the boss has become coated with a film of dirty oil. As the removal of the contact breaker is but a moment's work (merely the lifting of two spring-held wedges), the user should not experience much trouble in cleaning away the deposit. The user will also do well after having adjusted the contact screw and locking it by means of the little cheese-headed screw placed anglewise, to ascertain if the latter is really gripping. It occasionally happens—after long use—that the slotted jaw of the stub becomes permanently set, and incapable of being pressed together, which it is the purpose of the pinching screw to effect. The only course is either to substitute a new stub piece, or to get a mechanic to widen the slot with a hack saw.

The above mentioned replacements, which cost but a trifle, may be obtained from the De Dion London agents or through the factors, but the user must be careful before placing any in his spares-kit, to ascertain that each is of the current pattern.

(b) The Single and Four Cylinder De Dion Contact Breaker—1905 Pattern,

For adjusting the points in the form of contact breaker, which is now the type fitted to all De Dion cars except the two-cylinder models, it is only necessary to turn the cam shaft until the rocking arm X, which carries the blade, is at its furthest point of travel; then adjust the contact screw XX, just sufficient to deflect the blade about half a turn after contact, and lock by the angle-wise set screw. The milled screw X—projecting from the boss of the rocking arm X—is the means for adjusting the rapidity of the break. The motor should be started and the knurled nut operated. This, in turn, affects the degree of tension of the spring which influences the "pull off" movement of the rocking arm. The tension should be as light as possible to produce a sharp rupture. Some of the hints given as regards the old type contact breaker apply to the present one, but it will be seen that the altered placing of the contact points, and the style of blade used have removed some possible causes for derangement.

(c) The Two Cylinder De Dion Contact Breaker.

This contact breaker, like the one used on the single cylinder motors, can be disconnected without loosening the cam, by withdrawing the two milled buttons placed opposite one another, after having placed the axles of the cams in the required position, *i.e.*, with the boss of the cam upwards.

To adjust the contact points, first approach the white metal screws A of the contact spring B to about the same distance from each side (about 3 m.m.) (⅛ of an inch) the heads of the fork being on the neutral parts of the double cam C. The best method of affecting the adjustment is to advance the contact breaker to its limit of travel, then to turn the motor until the point of the cam actuates the rocking arm to its maximum degree of travel. Next, to adjust the corresponding contact screw about half a turn after contact, until it just deflects the blade. The other may then be similarly adjusted. It is desirable to have the slightest possible contact short of causing mis-firing at any speed. The motor may then be started, and the final adjustment of the contact screws made, when the same must be locked by the angle-wise screws in the stub pieces. To make sure that both cylinders are firing correctly, it is well to test each one by placing a thin card between the contact surfaces, interposing one just before withdrawing the other. The sound and speed of the motor when running on one cylinder will indicate the conditions which should exist when both are being fired correctly. For a final adjustment the motor should be set to run at its normal speed under working conditions, but it is not advisable to prolong the test on either cylinder as the amount of unfired gas drawn in will cause a series of back fires at the exhaust box.

To prevent end play at the contact breaker it is merely necessary to remove the contact breaker by raising the spring-held plungers which fix it. The sheet iron at the back may then be bent to give the necessary thrust, and the contact breaker replaced. Any looseness about the stubs which carry the contact screws should also be attended to, as if oil gets into the sockets or holes, mis-firing may ensue through faulty contact. Cleanliness about the ignition details is a first essential for the correct working of a motor. The bearing of the oscillating arm, which carries the contact blade, and the surface of the cams, should be kept lubricated—using only a thin mineral oil: an occasional drop will be sufficient.

Note.—The 1906 models of the two cylinder De Dion engines are fitted with a distributor and magneto ignition, and only a single blade and screw are used for the contact breaker, as in the case of the one and four cylinder engines.

3.—The Sparking Plug.

To test the sparking plug is the next point to claim attention. This is a small matter, involving no more trouble than the disconnecting of the wire at the plug connection, but taking care to have the current switched off first. The plug must then be removed, but in doing so care should be used to choose a suitable spanner. the object being to prevent rounding off the corners of the flat surfaces of the plug, and to avoid damage to the other portions of the mechanism in the event of the spanner slipping. A steady pull, by no means a violent one, is usually all that should be required to dislodge the plug. On removal, examine the points and note if same are not more than a millimetre or the thickness of a stout visiting card apart, also note if they are directly opposite, and should there be any sooty deposit about the porcelain top, carefully scrape it off with a knife blade, and rub with emery cloth, taking care, of course, not to alter the position of the pole points, presuming they are already correctly adjusted. A little petrol materially helps the cleansing process Next lay the plug on some convenient part of the engine and re-attach the wire, taking care not to let the terminal or sparking plug top be too close to the surrounding metal. The starting handle should now be operated, until the blade on the contact breaker makes contact with the screw; then switch on the current and while the blade is being lightly vibrated by the finger note the quality of the sparking across the pole points. Presuming the battery has been at the outset tested, the contact breaker correctly adjusted to the rules already given, it will be well, if the trouble is still undisclosed, to replace the plug with a new one. An examination of the faulty plug will no doubt show some internal short circuit—*e.g.*, cracked porcelain, or a broken central (*i.e.* positive) wire. The existence of either of these fatal defects is not necessarily observable when testing the sparking in the open, even a much less voltage would be sufficient to show a good result under such conditions, but it is a different matter when the sparking has to take place against an internal pressure of 60 to 80 lbs. to the square inch. The excellent quality of the De Dion porcelain plug—which is made in the firm's own factory—has now almost eliminated all troubles such as are dealt with above, and one may be easily found satisfactory even after twelve months' constant use, provided the engine has not been carelessly handled, or over-lubricated. If some other forms of porcelain plugs be used, it will be well to note that in one or more instance it is necessary to screw up the packing gland (if the plug be new) after the engine has been running a few minutes.

4.—The Coil.

The coil is often blamed for troubles with which it has no concern. As a matter of fact, a defective De Dion coil is a rarity, but when a failure or breakdown seems certain the amateur user will be well advised not to himself tamper with the supposed defective coil. Almost any capable electrician or electrical charging station has facilities for testing a coil, and the expense or delay in doing so need only therefore be trivial. As a guide to tracing a defect in the coil, it will be noted that a partial breakdown is to be looked for if a "ticking" noise is heard from the interior, or if the battery is too quickly exhausted, and an abnormal amount of sparking (resulting in fusing the points) is noted at the contact breaker. A test at the hands of an electrician will soon prove the nature of the fault, but the coil should be the last item in the electrical gear to receive attention, excepting of course an examination at the terminal connections.

Note.—The makers, who obviously should be the best authority on their own cars, do *not* favour the tampering with, or alteration of their cars' electrical details. They strongly deprecate the use of a 6 volts current with their coils—which are only wound to stand 4 volts. The substituting of a wipe form of contact breaker, or any species of auto-trembler they do not consider advisable, and it is well to remember the De Dion factory—employing some 2,000 persons—has a specially organised laboratory for electrical research. Buyers of second-hand De Dion cars should particularly note these points, lest they may be receiving an unwelcome legacy.

5.—The Primary Battery or Saturated Cell.

The De Dion cars up to the end of 1905 have been supplied with primary or self-contained generating cells, as distinct from accumulators or storage batteries. These are expected to furnish current for a distance of 3,000 to 4,000 miles. The makers do not endorse the practice of substituting accumulators to work with their coils; and they claim that best results are obtained with their own dry battery, a conclusion which our own experience bears out.

The cells furnished are four in number, their voltage should read 1.5 each on testing by the voltmeter; their amperage or volume of current should indicate when new not less than 10 for the complete battery. The battery should be periodically tested; for next to the wiring, no point of the car ought to receive more constant attention than this, the prime source of the car's power. This testing should be undertaken by means of an amperemeter, the use of which is explained farther on. Another testing instrument called a voltmeter is generally used for testing the voltage or pressure; but many authorities do not approve of its use in the case of a dry battery; and personally we consider that the amperemeter in conjunction with a tiny 4-volt lamp will give the more satisfactory results. The latter, by the brilliancy of the light, affords an excellent index, both of the amperage and voltage of the battery.

Before testing, care must be taken to see that the battery terminals are clean and free from verdigris or similar looking deposit. To that end, when a battery is installed, it is a good practice to smear vaseline over the terminals when the nuts have been screwed home. It will tend to preserve them from deterioration caused by the acid, or acid spray, and prevent their sticking or becoming set, and so cause delay when removing the battery. Should, however, such have occurred, a frequent fomenting with hot water and the application of some Scrubb's ammonia will readily make them pliable, but, if possible, no tool should be ever put near a battery terminal.

The cells may be tested singly or in series, but it is better to treat them separately. In connecting the wires of the amperemeter with the terminals of the cell, the volume of current it contains will be shown by the finger of the gauge registering the quantity on the dial of the meter. This should not fall below 3; when it does so it is a warning that the cell is nearly discharged. The reading should be taken quickly, as too long a contact with the amperemeter will be disastrous to the cell.

To test the pressure or voltage of a battery, the voltmeter is to be used in the same manner as the amperemeter Each cell should register 1·5; but if after use it should show a drop to 1.1, it is not safe to rely on it further, and it should be removed and another substituted.

The 4-volt lamp is to be used by placing the wires connected with same in contact with the positive and negative poles of the battery respectively.

It is usually possible to temporarily revive a weak battery by moistening or re-saturating the contents. For the purpose place two ounces of sal-ammoniac (failing this, common salt will do), in an earthenware basin, and pour over it nearly a pint of hot water. While the solution is cooling, bore a hole through the pitch on the top of the cell, and keep pouring the solution, say a teaspoonful measure at a time into each cell in turn, finally closing the hole with a little melted pitch or sealing-wax. It cannot be too strongly impressed that this is but a temporary cure, and should only be resorted to in the absence of a spare battery. Another point to remember in connection with a primary cell is that after usage, if allowed to rest a while, it partially recovers its voltage. This, however, is only a temporary recovery, and when the supply of current is drawn on again, the voltage will quickly drop. It is, therefore, well to test the battery immediately after a journey rather than before one. It is hardly necessary to say that a spare battery should always be carried when the one in use is half run down.

The Accumulator or Storage Battery.

As some users who have facilitites for quickly re-charging batteries prefer to use the storage type, or accumulator, it may be well to submit a few notes on their proper up-keep. The two chief points to observe are—firstly, that the accumulators be constantly kept charged; and, secondly, that the electrolyte (dilute sulphuric acid of best quality) should be maintained at the specific gravity, specified by the makers. An accumulator so used will last for years. The type used for motor car ignition consists of two cells joined together internally or externally, which give when fully charged a voltmeter reading of 2.2 volts each or 4.4 volts the pair. Almost immediately after being put in use the voltage will drop to 4 volts, and will remain at that point until the battery is nearly exhausted. It will generally be found unequal to furnish sufficient current for the coil when the voltage drops below 4; and under any circumstances no dependence is to be placed on its capacity to do so for any length of time, though in some cases the car will run until it has reached 3.8, but at the risk of injuring the accumulator by the sulphating of the plates that will then begin. All accumulators are sent out with the proper strength of the electrolyte to be used marked on them, together with the amperage or capacity of the cells, and users should strictly adhere to those instructions. Accumulators in constant use should be kept continually charged (once a fortnight is not too much), if not in use, at least once in five weeks.

To test an accumulator for voltage, the voltmeter should be used. This can be done precisely after the same fashion as testing the dry cells before treated of. There is but one possible cause of trouble with accumulators—danger of their short circuiting internally. This is caused by one of the plates becoming bent or detached and touching the corresponding member of the cell. It may also be caused by particles of mineral matter gradually silting up the space between these plates, but the result will be the same. The remedy is beyond the skill of the average car owner to effect; and it is better to send the accumulator back to the makers, or some competent electrician. It is well not to use any but rain water or filtered water to fill up accumulators, and users should note that the liquid must always cover the top of the plates, as by leakage and evaporation it gradually finds its way out. It is also advisable to change the electrolyte occasionally, but when to do this is best left to the discretion of the person entrusted with the charging of the accumulator, who by means of the hydrometer will test the specific gravity of the fluid. In some cases De Dion cars will not run satisfactorily with accumulators, unless a 6-volt battery is used; and with the increased voltage there is the risk of damaging the coil.

The Voltmeter and the Amperemeter.

The purpose of a voltmeter is for ascertaining the strength or pressure of the current available in a secondary battery. It affords no criterion of its capacity—in ampere hours; thus a battery which showed 4 volts in the morning, may have become reduced to 3.8 volts by the evening, and after only a brief usage of the engine. For this reason, the 4-volt lamp should also be used, as its brilliancy furnishes a reliable index both to the presure of the current and to the volume remaining in the battery at the time of testing. To test an accumulator, place one of the wires from the voltmeter in contact with the positive pole which is either coloured red or marked + and the other to the negative pole marked —. Contact should not be longer than is absolutely necessary to get a correct reading, and, as before remarked, the voltmeter is not satisfactory in the case of a dry cell.

The amperemeter is used to measure the volume of current passing from the cells. It is applied in the same way as the voltmeter, and its use is to be commended when a primary or saturated battery is used. When the reading falls below 3 amps. the battery may be considered unreliable.

Carburetter Derangements.

Stoppage in the petrol supply will rarely occur if when filling the tank the petrol is poured through a funnel fitted with a fine mesh gauze. Some care should be exercised in purchasing a petrol funnel; it must be one that is fitted with a very fine mesh gauze (one that will permit water to pass is imperfect), and had better be purchased from a dealer in motor sundries.

It is well to occasionally open out the carburetter, and remove the spraying nipple by means of the key supplied for the purpose, and then to carefully wash out the interior with petrol, stale or otherwise. Great care must be exercised in dealing with this piece of mechanism. The dissection of the carburetter in day light is a comparatively easy task; but at night time it is another matter, and one cannot be too careful in attempting such work when an artificial light has to be employed. For this reason, it is better to make the care of the carburetter a matter of occasional examination in the same way as the user will test the battery, etc., and not leave its care to chance. As there is always in petrol a varying quantity of water, it is well to occasionally remove the milled edged cap at the bottom of the carburetter at the junction of the petrol feed pipe, and allow the latter to flush itself. Needless to say, this is a much easier matter than dissecting the carburetter.

To take down the carburetter it is necessary to detach the three pipes—viz., air inlet, gas outlet, and petrol feed pipe, and also the rod connected to the carburation lever. The carburetter may then be unbolted from the bracket supporting it. At the base of the tube attached to the float-chamber there is a spring and a gauze filter for the petrol, the detaching of which may be done without disturbing the carburetter body for the purpose before mentioned. The tube itself may be detached by undoing the union (or nut) securing it to the float chamber. When removing this tube, care must be taken to prevent the weight falling out, the same being hooked over the balance piece. In the same way when re-assembling, care must be used, and the screw in the end of the needle valve must have its head hooked over the end of the fork lever, so that the under side of the head will be in contact with the top side of the lever. Without this observance of detail, the feed apparatus will be in-operative.

It is not necessary to tamper with the lever to open the top portion of the carburetter. By undoing the nut just below the lever, on the earlier model, or the two screws holding the cover in the later, the sleeve of the carburetter may be withdrawn, thus exposing the sprayer, a key (supplied by the makers) being necessary to detach the latter.

The float chamber is opened by taking off the nut at the base of same, when the whole may be removed. It should be noted that there is a lead washer between the two portions, which must be re-placed when re-assembling. As a matter of fact, it is very seldom necessary to remove the entire carburetter from the frame, as all the essentials may be dissected for inspection without disturbing the trunk.

It may happen that the float (a light-weighing, hollow spun cylinder) may become leaky, and fail to function correctly. This trouble is easy to discover; the feed chamber becomes over-filled, the petrol leaks out, and the balance of the mixture becomes upset, which may cause the engine to stop. To deal with this trouble, it will be necessary to remove the float, and carefully test for the seat of the puncture. As a rule this will be found in the region of a soldered joint. Sometimes the place will be discovered by carefully drying the float, and watching the surface—at the top, base, and sides, when the leaky part will show itself by the moisture surrounding it. If it cannot be discovered at once, get a basin of hot water, and place the float in it. Under the influence of the heat the petrol will vaporise, and tiny bubbles will indicate the hole. Mark the position of the hole, and then replace the float in the water with the hole downwards. The pressure of the vapour inside will force the petrol out.

Wait until the float has cooled, and then carefully close the puncture with solder, filing off the superfluous material so as not to upset the balance. If the tool box does not include soldering appliances the punctured float will bring one to the end of the day's journey, provided the leakage is not a big one. If a considerable quantity of petrol has got into the float much time will be saved by making a tiny hole opposite the punctured place and blowing through it. Both holes can then be soldered up, care being taken only to use the smallest amount needed, or the balance action of the float may be altered.

The only other cause of an over supply of petrol to the float chamber is that the needle valve fails to close or seat tightly. The remedy is to re-seat it by having the point turned, care being taken not to bend or damage it in the process.

It may happen (though very rarely) that the needle valve will stick. This will be found due to the controlling arm jamming, the result of wear, or the needle binding in the tube. A touch with a small file at the point will put the matter right. It is well to occasionally disconnect the petrol pipe from the tank as well as at the carburetter, and cleanse it by blowing through it. At the same time the operator should note that it has not become displaced or bent, as sometimes excessive vibration or other rough treatment will cause a section to come in contact with the car frame, etc., and become flattened and almost wear through the surface. An air lock between the tank and the carburetter is only possible when the vent hole in the cap of the tank gets choked. As it is a possible cause for irregular feeding to the carburetter it is here mentioned. The same applies to a commoner form of trouble often overlooked by novices—*i.e.*, to see that the nuts on the vapour or mixture pipe to the engine are properly jointed and screwed home. These joints should be faced and air tight—otherwise the degree of the vacuum will be diminished, and the volume of mixture similarly influenced.

Fractured Pipes.

The user should include in his list of spares a few inches of rubber hose, of a bore to suit the external diameter of the water pipes. It is well also to carry a roll of rubbered tape in a box by itself. With these and a few feet of thin copper wire almost all difficulties on the above score may be overcome. It is well occasionally to give a look to the unions or couplings at the end of the pipes, particularly to the petrol feed pipe.

A Bent Axle.

In the event of an accident, due to side-slip or collision with another vehicle, it is advisable to at once examine the axles. Damage to the front one is usually detected by its causing the steering gear to become strained or erratic. The condition of the rear axle is not so easy to discover. One advantage of the De Dion cardan system is the latitude it permits in such a direction, for while the wheels may run wobbly, the transmission gear may be hardly affected, and the car be quite safe to continue using, whereas with other forms of axle, the whole mechanism would become strained. For the purpose of inspection the rear wheels should be lifted (a small screw jack will be found a necessary adjunct to the tool outfit) in turn, and the half axle revolved. Any ill effects as regards straining will be detected by the appearance of a "tight" spot. This test should not, however, be regarded as sufficient. According to the nature of the accident the user can judge its possible effects. There is the danger of a bent axle (according to the nature and situation of the bend) breaking subsequently "short" at the point, so that under any circumstances any visible damage should as soon as possible be inspected thoroughly. For the purpose a fair sized magnifying glass will be found useful, and requires no trained skill to use. It should also be remembered that a wobbling wheel causes much wear on the tyre.

Rusting up of Joints or Moving Parts.

Ordinary rust, if not permitted to penetrate deeply, may be readily removed by brushing the parts with paraffin oil, in which a little lime has been slaked. When the surface has been cleaned the joints or knuckles should be well oiled. These instructions particularly concern such movements as the brake rods, the leaves of the springs, and any rod having as a means of adjustment a screw and nut. If by chance any such should become "set," *i.e.*, impossible to disturb without risk of straining or breakage, a petrol blow-lamp—which will be found a useful adjunct to the repair outfit—may be used to heat the part. The application of a little paraffin will then suffice to clean the scale, and the nut may be readily slacked back.

CHAPTER VII.

POSSIBLE DERANGEMENT OF THE ENGINE AND CAR.

The simplicity of the De Dion engine, apart from the excellent work put into its construction, is one of the factors which have contributed in no small degree to its popularity. Short of ill-treatment the engine will run an entire season without being "opened up," so that the user need only devote his attention to its adequate lubrication, and avoid punishing it by unfair treatment when driving, or neglect of other details about the car.

(a) Overheating.

Over-heating is a ready source of loss of power. It may arise from several causes—*e.g.*, lack of adequate lubrication, or the use of an unsuitable lubricant, failure of the pump—partial or complete—insufficiency of water in tank or radiator, and want of skill by the driver in the manipulation of the carburation and ignition levers.

In its first form it is generally accompanied by a "knock" in the interior of the engine, and a gradual diminishing of the engine's power. This latter may be followed by an actual seizure of the piston—*i.e.*, the piston becomes, as it were, locked in the cylinder, and sometimes cannot be disturbed even by a violent attempt to turn the starting handle. The first remedy to adopt is to wait until the engine has cooled, and then (having removed the sparking plug) to pour in to the combustion chamber about a gill measure of paraffin, whence it will find its way over the piston head, and after a few minutes penetrate between the piston and the sides of the cylinder. The starting handle may then be tried. If after a few moments' effort it is found impossible to move the crank shaft, it will be necessary to remove the cylinder. The method of doing this will be dealt with later.

The second source of trouble—failure of the pump—may be caused by a fracture within the pump case—*e.g.*, failure of the spindle to rotate the vanes—exceptional leakage between the sides of the vanes and the pump flanges (this can only occur under such an abnormal circumstance as the use of grit containing water, or after long usage); silting up of the pipes due to foreign matter in the water, or an air lock in the circulation system—especially to be looked for when the water has reached the violent ebulition stage—*e.g.*, when nearing the end of a long and steep hill climb. The user will readily detect the first cause by noting the cool temperature of the pump compared with the cylinder jacket, and the pipes adjacent to it. Experience, and probably trouble, with other parts of the mechanism, will warn the user when the car is calling for a general overhaul.

An air-lock will readily right itself if the heated radiator system is given time to cool; the steam will then be condensed. If one occurs under other circumstances the removal of the plug cap at the base of this pump, while the engine is running, will effect a cure.

Shortness of water in the tank and radiator requires no comment, except that it is a ready source of over-heating. The tank should not be replenished until the engine has cooled except boiling water is used.

An over rich mixture, undue retarding of the ignition lever, failure to keep the exhaust valve a tight fit on its seat, resulting in a partial loss of compression, and lack of elementary skill when driving up hill are some of the features which will contribute to its cause. Most of them the readers will have anticipated, and their prevention has been largely dealt with earlier.

(b) Loss of Compression.

The importance of this point cannot be over-estimated. With an inadequate compression over-heating, or at least an abnormal waste of petrol is bound to follow if the car is being much pushed. To test for loss of compression it is merely necessary to turn the starting handle—the current being switched off. If the engine can be revolved with only a partial feeling of resistance at the starting handle the needful degree of compression is absent. This leakage may proceed from any part of the cylinder head where there is a joint—*e.g.*, 1st, at the sparking plug; 2nd, at the exhaust valve; 3rd, between the cylinder walls and piston rings; and 4th, at the inlet valve.

Leakage at the sparking plug may be easily tested by using a little soap-suds or some such mixture, and rubbing same round the joints of the plug itself, such as about the porcelain and at the junction with the cylinder. On turning the motor, air bubbles will be noticed at the point of leakage.

2nd, The pitting of the exhaust valve is a common cause of compression trouble. To effect a cure, the inlet valve cap with the suction pipe must be detached, when the exhaust spring can be removed. To facilitate this task, which merely consists in lifting—*i.e.*, depressing the stout spring sufficiently to enable the cotter and cup washer to be removed, a neat little tool may be obtained through the makers for a few pence. Its use will prevent any danger by jamming or slipping to the users' hands. In the absence of a special tool, it will facilitate the removal of the spring if a medium weight spanner or similar implement of sufficient weight be inserted into the opening from the valve chamber to the combustion chamber. The object is to enable the operator to keep the exhaust valve seated while the spring is being lifted preparatory to removing the cotter key and washer.

3rd, The inlet valve also may be pitted, and require grinding; or there may be a leak at the seat due to the bolt not having been screwed home. When replacing the valve, great care should be taken in putting the dome back into its proper position, and not to use undue force to the bolt which holds it—an operation which might result in crushing the dome. A new properly made copper and asbestos washer will frequently effect a considerable improvement in the compression, also a new inlet valve spring. The remedy for loss of compression under this heading is to regrind the valve on its seating. This process has already been described under "Care of the Engine and Car," Chap. IV.

4th, Leakage past the piston rings can usually be tested by the temperature of the crank chamber. If hot, it is a fair index that the trouble is to be found there. A remedy for this trouble, which has often been found effective, consists in substituting an oil in the crank chamber with more viscosity, but this point has no reference to the standard grade of oil supplied for cylinder use by the leading houses, or the makers of the De Dion cars. Sometimes, too, a flushing of the cylinder with paraffin will effect a cure, but a fresh charge of oil must be pumped in after the other has been drained off.

(c) Worn or Damaged Piston Rings.

After about two season's average usage it is advisable to examine, and, if found necessary, to renew the piston rings. It may happen that such a course may be made necessary earlier by the breaking of one. In the latter instance, its presence will be easily detected by the "clicking" noise that will be heard best when the motor is running slowly. To remove a cylinder no great skill, but much care, is required. It will be necessary to detach any fittings that will interfere with its easy removal; the wiring should be carefully disconnected and looped up out of the way; the water connections that directly touch the cylinder should be dismantled, and the inlet and exhaust pipes must be carefully put on one side. The four nuts which hold the cylinder to the crank case can now be removed, and the cylinder lifted off. It is just then when care is most wanted, and it should be noted that any *side* pulling or undue straining must be avoided. Provision against anything falling into the crank chamber must be made. This can be done by placing a piece of clean rag (not cotton waste) over the crank chamber mouth The cylinder being carefully put on one side, proceed to examine the rings, but first note the position of the slots or openings. These should be spaced about one-third apart, which will ensure the piston being gas tight, and no two slots will be opposite. It should also be noticed if the rings are what is termed a true fit; this will be seen by the polished surface being equal all round. When such is not so, or if there be a marked discolouration or evidence of scratching (scoring it is termed), the ring is not a good fit; and it will probably be better removed and another substituted. One should particularly notice if the rings move freely in the grooves of the piston; if not, cleanse them with paraffin oil; and when moving freely, test their elasticity by merely pressing them with the finger to close the slot. To remove a worn ring is a job that requires a little care, and is best effected by inserting the small blade of a penknife at the slot and lightly expanding the ring. A few narrow strips of tin, about four inches long, are here useful; they serve as wedges, and can be pushed in between the wall of the piston and the inside edge of the ring in a vertical line. By inserting one at intervals, as the knife blade is partly traversed round the ring, the latter's removal will be easily assured, and it will pass over the other rings by merely compressing them. Before inserting a new ring it must be seen if it is a correct fit for the cylinder. To do this it must be inserted at the cylinder mouth, and gently worked in, care being taken to push it evenly when doing so. If the ends tend to overlap, it is evident that it is a little too large, and it will be necessary to ease it by filing the edges of the slot; but as very little will often be sufficient, care should be taken lest too much may be removed. Before slipping over the piston, the ring must be tested to see if it is a fit sideways in one of the piston grooves. This is easily done by trying its back—so to speak—in the groove; it should move easily in it, but with no undue amount of looseness. If it should prove too tight a fit, filing must be resorted to, and to do this effectively, the ring should be placed on a flat board into which a couple of small sprigs have been driven, the heads of which should be just below its top edge. The ring can then be placed against these "stops," and a small file gently used over the surface, but care must be taken to file evenly over the whole surface. To replace a new ring the same procedure can be followed that was used to remove the other. The cylinder can then be replaced, care being again used to prevent the ring slots being less than one-third apart, and that no undue pressure is used to push the cylinder home. When recoupling at the flange, it is well to turn each nut a little at a time so as to equalise the pressure and to put only moderate pressure on the spanner, until the engine has been run a few minutes, when a better and final tightening up can be made. A mediumly thick brown paper jointing ring, smeared with boiled oil, should be interposed between the crank case face and that of the cylinder flange before re-placing the latter. It should be added that in a case where a piston has stuck—fired as it is called—it is generally advisable to entrust the freeing of it to an experienced mechanic. It is also advisable, when the cylinder is detached, to scrape the top of the piston and the interior of the cylinder (combustion chamber) as the accumulation of much carbon there will cause premature firing when the cylinder becomes heated.

(d) Knocking or Thumping at the Engine.

This may arise from three causes:—As a premonitory sign of inadequate lubrication of piston and gudgeon pin, premature firing, and a loose bearing or want of adjusting of some moving part.

The first has already been emphasised.

Premature firing may be due to the cause above mentioned, but cannot happen to an engine except it has been improperly handled—*i.e.*, if the driver has not had much practice and been using an over rich mixture, or been using paraffin too freely for cleansing purposes, and starting up the motor with not sufficient interval for the oil to drain out, or repeated excess of lubrication, and, what is of perhaps more importance, the use of an unsuitable grade of oil. The constant discharge of smoke from the silencer is a ready warning of possible premature firing due to the above causes.

Premature firing may also be due to want of care when driving—*e.g.*, failing to retard the ignition lever to suit the possible speed of the engine on a hill, or when labouring with too high a gear in mesh. The user should study this feature of the engine closely, and ascertain the best position of the ignition lever for its most efficient running The point will be found dealt with in Chapter V.—"How to Drive." Knocking due to the above causes may be considered temporary—*i.e.*, it may be stopped without mechanical adjustment.

A knock, which is constantly heard, is, on the other hand, an evidence of a worm bearing—*e.g.*, at the coupling between the connecting rod, and piston (termed the gudgeon pin) or the crank shaft bearings. Continued premature firing will readily set up much wear at this place, as also in the crank shaft bearings. Occasionally, too, it may result in breaking the crank shaft, or the connecting rod, as an enormous hammer-like blow equal to nigh 280 lbs. pressure is being constantly delivered at those points. It is needless to say that a considerable amount of power is thus directly lost; while the re-action also induces the thump-like effect noticed. The user should not neglect the continuance of such a knock, or the results may rapidly become serious.

An occasional source of trouble, resulting in knocking and loss of power is attributable to one or both of the internal flywheels becoming loose on the axle spindles, or to a similar trouble at the crank pin. Such a trouble may itself be caused by constant abuse when driving, or (in the case of old engines) as a result of long usage, especially if the parts concerned have been tampered with, when other repairs were being effected. The effect of the loosening is to cause the wheels, axle ends, and crank pin to run eccentrically. It will then be necessary to "true" the crank pin and wheels in a lathe—not by re turning—but by moving the parts until they again register correctly. These remarks only concern the smaller De Dion engines; those having an external flywheel only require the bolts which affix the wheel to the flange—(the latter being solid with the crank shaft)—to be occasionally examined and kept taut. In all cases of knock the user should satisfy himself thoroughly before dismantling the engine that the trouble is there localised, for it is at times traceable to another portion of the transmission gear—*e.g.*, loose or worn gear box bearings, undue play (after wear) in the rod joints, the latter being usually marked by a species of "rattle" rather than knocking.

(e) Adjustment of the Exhaust Valve Regulator and Valves.

The exhaust valve regulator should be so adjusted that when the pedal is at its lowest point it only just fails to stop the engine. At the same time the exhaust valve lifter should be at the highest point when the pedal is raised; that is to say, there should be only room for an ordinary visiting card between the valve lifter and the valve stem when the pedal is at the highest point. To alter the adjustment is a very simple matter.

The regulator is operated by means of three rods or levers, and can be adjusted by altering the length of the middle one. It should be first disconnected from the lever nearest the regulator, and the end which forms the connection can then be screwed either up or down on the rod, so as to reduce or increase its length. After the change has been made the mechanism should be tested so as to make sure that it is acting properly. On the De Dion cars having a combined throttle lever and exhaust valve regulator movement, similar care must be taken to note that the adjusting of one does not incorrectly affect the other.

Correct Adjustment of the Timing Gear.

This is obtained by setting the exhaust valve to commence to lift when the piston is about 5-16 in. from the end of the down stroke, and closing same when the piston is almost at the top of the return or up stroke. A cycle spoke will be found useful to gauge the positions of the piston for the respective movements. It may be inserted through the compression tap hole (if there be one fitted) or by removing the sparking plug, though the latter will be found a more difficult method.

The exhaust valve should have a maximum lift of (approximately) ¼ of an inch when the engine is running ungoverned.

The cam lifting the valve is case-hardened, and will show little signs of wear for at least 10,000 miles' use. The valve spindle, which should have only a small clearance from the tappet, will gradually (after much usage and re-grinding) remain in permanent contact with the tappet. This will reduce the compression, and the end of the spindle must be filed to give the necessary clearance (1-25 inch). The correct timing of the engine has already been dealt with, but the user is here warned against experimenting with it, as an error of a tooth in the meshing of the gear will considerably affect the power.

The inlet and exhaust valve springs will occasionally require renewal. The makers supply such parts at a nominal cost, and of the correct tension to suit the engine.

As regards the inlet valve spring, one too light will prove a cause of loss of power through the valve shutting irregularly, and not promptly; whereas one a trifle too heavy will be equally sluggish in opening, and not permit sufficient mixture to pass. The exhaust valve spring requires to be of sufficient strength to promptly seat the valve, and resist the suction effort of the piston to open it. It is a mistake to use one of too great strength, as it will unduly wear the profile of the cam, the tappet, and the teeth of the distribution gear.

How to Adjust an Expanding Clutch.

When one of the expanding clutches fails to bite it is necessary to re-adjust the expanding segments, but in such a way as not to disturb the efficient working of the other. Fig. 43 illustrates the normal or correct position of the adjusting mechanism.

The change speed gear is properly adjusted when the lever I has an equal movement of fifteen to twenty degrees on each side of a position at right angles to the car. Set at right angles, the engine should be free, and when revolved by the starting handle there should be no tendency to drive the car forward.

Instructions for adjusting gear when the lever I is at right angles with car when out of gear. and the movement forward or backward equal, but too great, allowing clutches to slip, or too small, and not allowing the engine to be free.

If the movement is too great, the clutches require expanding, and if too small they require contracting:—

1. Place lever I in position in the middle of its movement.
2. Raise bolt E.
3. By means of knurled ribs D on C turn A about one-eighth of a turn in the direction required to expand or contract clutches as the case may be.
4. Lower bolt E.
5. Turn A in same direction until bolt E falls into the next groove B in rack A. This will have given the rack A half a turn.
6. The extremity L of cap C should now have a movement of about ¼ inch on each side of line G on axle R. If that is not correct give rack A another half turn as instructed.

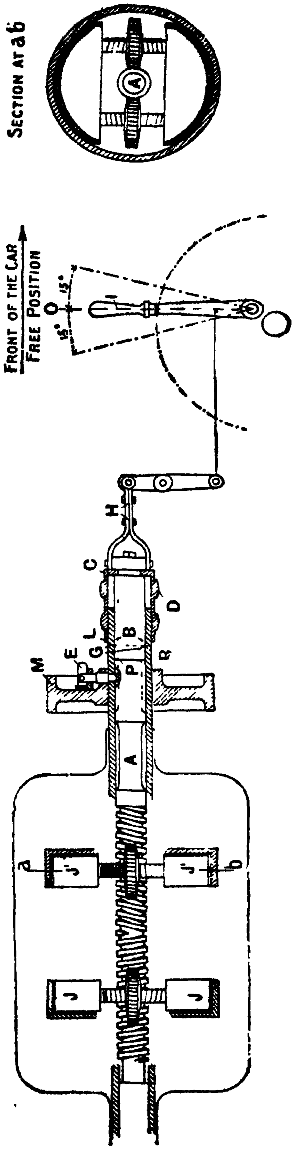


Fig 43.—DIAGRAM TO ILLUSTRATE METHOD OF ADJUSTING OF EXPANDING CLUTCHES.

7. Place lever I in the out-of-gear position, and turn starting handle of motor to ascertain whether the gear is free. If the car moves, or the crank shaft of the engine seems stiff to turn, the clutches have been expanded too much.

Very Important.—Do not move lever I or pull or push the rack A unless the bolt E is engaged in one of the grooves B. Do not turn the rack A when lever I is not in the centre of its movement—*i.e.*, the out-of-gear position.

Instructions for adjusting the clutches when the movement of the lever I is greater on one side of the right angle position than the other:—

1. Observe on which side of the line G the end of cap, C, attached to A, has the greater movement.
2. Place the lever, I, in position in the middle of its movement.
3. Unbolt and take off the two rods H.
4. Raise bolt E.
5. By means of knurled ribs, D on C, turn A about six turns in the direction required to contract the clutches, being careful to keep the end, L, of the cap C near the circular line G.
6. Lower bolt E.
7. Turn A in the same direction until the bolt E falls into the next groove B on rack A.
8. Pull A about 1¼ inches towards the front of the car, when the circular line P on the rack A should appear at the end of the shaft, R.

   [In the speed changing gear, where the line P does not exist, the above distance can be measured from the end, L, of the cap C to the circular line, G.]
9. Raise bolt E.
10. Turn the cap C one-eighth of a turn as follows:
    (1.) To the right, to screw inwards, if the movement of the cap C is greater on the side of the line G towards the back of the car. (2.) To the left screw outwards if the movement of the cap C is greater on the side of the line G towards the front of the car.
11. Lower bolt E.

12. Turn A in the same direction until bolt E falls into the next groove B in rack A.
13. Push back the rack A until the end I of cap C reaches line G.
14. Raise bolt E.
15. Turn A about six turns in the direction required to expand the clutches, being careful to keep the end I of the cap near line G.
16. Lower bolt E.
17. Turn A in the same direction until the bolt E falls into the next groove B of the rack A.
18. The extremity of cap C should now have approximately an equal movement of about ¼ inch on each side of line G. If unequal the operation must be repeated. If equal but with greater or less movement, than ¼ inch on each side of line G, adjust, as per instructions on second page.
19. Replace parts H.
20. Place lever I in the out-of-gear position, and turn starting handle of motor to ascertain whether the gear is free. If the car moves, or engine revolves stiffly, the clutches are expanded too much.

The above instructions also apply to the 4½ and 6 h.p. voiturettes with motor at the back, but instead of disconnecting the ball bearing from the rods H, it should be detached from the bracket which holds same by means of two bolts.

Very Important.—Do not move lever I or pull or push the rack A unless the bolt E is engaged in one of the grooves B.

Do not turn the rack A when it is not in the free position or drawn out so that the two pairs of clutch pinions are engaged with one thread only of the rack.

If these two instructions are not followed there will be great risk of revolving one pinion less than the others, with the result that the clutches will not be parallel, and when expanded will not form a part of a true circle and make proper contact with the inner surfaces of the clutch drums. When the adjustment of a gear is upset in this manner, it is necessary to take it entirely to pieces and re-assemble it again, but that is a task which should only be entrusted to an experienced De Dion mechanic.

NOTE.—As in some models it is necessary to turn the rack A to the right, and in others to turn same to the left to expand the clutches; the user should find out by experiment in which direction to turn the rack to expand the clutches of his car. In all cases turning in one direction expands, and in the other contracts both the clutches simultaneously.

From the foregoing sets of instructions it will be understood that

1. Sliding the rack A in one direction expands one and contracts the other clutch. Movement in the opposite direction reverses the action.
2. Revolving the rack A in one direction expands both clutches equally; in the other direction contracts both equally.
3. Drawing the rack A out 1¼ inches (after contracting the clutches to allow this movement) brings all the four small pinions engaged with the rack on one thread. In all gears this is a right hand thread. Revolving the rack when in this position simply screws the rack in or out without affecting the adjustment of the clutches themselves. In other words, it simply adjusts the position of the rack.

It is well to observe that the fibre of the clutches is subject to weather influences if of a marked character. In addition the use of too much lubricating oil, or oil unsuited for the purpose, will cause the fibre to expand. The gear box should only be filled, and kept so to the level of the over-flow hole, which is provided with a test plug removable for the purpose. The use of unsuitable oil will produce the same ill result. To effect a cure, first draw off the oil from the box, next pump in almost a quart of petrol and paraffin mixed, start up the engine, and let the fibre segments get a good splashing, and finally drain off the oil. The petrol will remove the grease, and the clutch will contract. Then pump in a pint of Huile D., or the special oil marketed by the De Dion firm, and don't exceed that dose. The clutches should after an interval be again tested, and if it be found that the trouble still continues, it will be necessary to readjust the clutch segments as before described.

How to Adjust the Disc Clutch.

The pedal-operated disc clutch—fitted to various models of De Dion cars—is adjusted in the following manner: At the rear of the clutch will be found a small elbow catch-piece held by bolt and nut. On slackening the nut, the catch can be pulled back, thus freeing the ball bearing case. The case can then be revolved, when, by turning *to the right* the clutch may be adjusted to compensate for any wear that has taken place. The case has a number of notches to enable a fine degree of adjustment being obtained. After the adjustment has been made, the catch piece must again be screwed up.

NOTE.—When properly adjusted it should be possible to draw the fork actuating the clutch out of contact with the ball bearing. To test this, note whether the clutch pedal can be raised by hand from its position when at rest; there should be a free upward movement of about one inch.

As regards lubrication:—The clutch shaft is bored, and the hole in the exposed portion is covered by a spring. The grease pump supplied for the wheels is fitted with a nozzle for screwing into this hole. The lubricant is then forced through the shaft, and holes (drilled for that purpose) into the clutch bearings. The grease should be injected until it exudes from under the ball bearing.

Note to the Reader.

As it is obvious that the treatment of many of the technical details, generally referred to in the booklet, has been necessarily brief, and some, perhaps, inadequately so in view of their importance as regards the correct running of the car, the reader is referred to the "Encyclopædia of Motoring" for fuller infomation. That work is obtainable from the *Motor News* Offices, 34 Lower Abbey street, Dublin, or from Messrs. Iliffe and Sons, Coventry.

CHAPTER VIII.

HOW TO CARE THE TYRES.

The care of the tyres is one of the most important matters in the successful running of a car. The chief points to observe are:—1st. To keep the tyres fully inflated, but not too hard, as such will cause excessive vibration. A good test for this is to pull the wheel forcibly sideways to and fro. If the wheel unduly rolls, it may be taken as a proof of the tyre being insufficiently inflated. When the car is fully loaded, the flattening of the tyres where they rest on the ground should be only just appreciable. 2nd. Care must be taken not to take corners at an unreasonable speed. 3rd. The brakes should never be jammed hard on, except in an emergency. 4th. Care should be exercised to see that rust is not permitted to appear on the rim of the wheel; it is one of the commonest causes of rotting at the edges of the covers. It is a good practice to occasionally remove a tyre; and, after emery-clothing the rim bed, to give it a coat of good air-drying enamel, and even a second if time will permit, and then polish with graphite. 5th. It is advisable to blow out any dust that may be in the pump before inflating a tyre; and care should be taken that the dust cap over the valve is always screwed up after inflating the tyre. 6th. See that all fixing bolts are screwed up tight, while the tyre is being inflated and again when it is fully inflated before leaving it. A look should occasionally be given to these bolts when on the road, as they are apt to become loose. Bent bolts should not be used—they won't seat properly—also it is necessary to see that the canvas-covered flange which secures the cover on the rim, and on which the tube itself rests, is perfectly in place, as any friction at this point will soon prove fatal to the tube. 7th. Always carry a spare tube, it will save time when a puncture occurs. 8th. Never neglect a cut in a cover, even if it be only a surface one. 9th. Never drive on a deflated tyre; it may be damaged beyond repair, and a new cover and tube will probably be necessary. 10th. No grease or lubricant should be permitted to come in contact with a tyre; and spare tubes and covers are better if kept canvased up, and in a place where the temperature does not exceed 70 degrees F. 11th. Graphite brushed on the inside of a rim facilitates fitting a new cover.

How to Remove a Tube.

When it becomes necessary to remove a punctured tube, the first process is to lift the wheel off the ground by means of a jack. For this purpose, it is much to be commended that a Lucas, or Lake and Elliot, telescopic jack be included in the outfit the motorist should invariably take with him. The space such a handy little article occupies and its weight are mere trifles. To remove the tube, the bolts that hold the cover on the rim must be slacked back, the butterfly nuts being run up to within a couple of threads from the ends; the valve cap and valve must be removed and the pinching nut below also, care being taken to put these items carefully on one side, but in particular clear of any dirt that may be about. The bolts and valve stem must now be depressed into the bed of the rim; this may necessitate some little pressure being used, but if unyielding to this, a smart but not heavy blow may be given, but only in a vertical direction, or the bolt stem will be bent and a troublesome job result. When the bolts are free, the outer edge of the cover must be freed from its seat in the rim channel. That is done by grasping the cover by the hands and exerting a thrusting and, at the same time, a pinching strain in the direction away from the rim edge. This must be followed up for the whole of the circumference of the cover, by which time it will have become sufficiently yielding to enable the end of the tyre-detacher lever to be inserted under the edge of the cover. The tool or detacher to be used for this purpose must be no make-shift article; it should be one such as is supplied by the tyre makers for their tyres, and should be strong enough to enable the worker to accomplish the job without any adventitious aid. The best place to choose for the inserting of the detacher point is one about equi-distant from any pair of the holding on bolts. When the detacher point is successfully inserted, the cover edge should be lifted up by pressing the end of the detacher downward. A second detacher must now be inserted a few inches from the first, and gradually worked round the rim until nearly opposite one of the holding on bolts, when the bolt should be well depressed so as to enable the detacher to successfully lift the cover edge from under the fang of the bolt. In this way the tools may be worked for about two-thirds of the wheel's circumference, when the cover will readily yield to the slight extra pressure needed to free the whole of the edge from the rim. When this is done, the tube may be readily removed, but care should be used in pulling it out of its bed, lest it be torn or unduly stretched. When it is necessary to detach the cover completely from the rim, the holding down bolts must next be removed after the tube. The inside edge of the cover can then be manipulated in a similar manner to the way above described, the strains being exercised in the opposite direction: but little difficulty should be found as it will readily yield to a little pressure.

How to Replace a Cover and Tube.

In replacing a tube the greatest care must be taken to guard against any twist, as such will prove a source of trouble later on. Presuming it has been replaced correctly, proceed to partly inflate the tube—a few strokes with the pump will be sufficient—and then work the hand inside the cover and under the air tube to make sure that the latter rests fairly on the top of the canvas-covered flanges, that it is not nipped by them, and that the canvas covering of the flanges is not crinkled, or doubled back on itself. To get the cover back into its place, push the stem of the valve up high into the tyre, and carefully getting the edge of the cover (at the point where there is a small piece cut out), under the flange of the valve, and into its proper place, tuck the cover gradually into position under the edge of the rim, taking care as each bolt is approached to push it up until it is flush with the felloe, so that the edge of the cover is sure to get under the flange of the bolt. The tyre remover lever may be used for pushing the beaded edge of the cover home; the last bit is usually the most troublesome, but with a little energy it will be accomplished. The cover should next be pushed sideways to and fro, not too roughly, to make sure that every part is in position. The tube may then be fully inflated, but the several butterfly nuts and the valve nut should be constantly tightened while this is being done, and again when the task is completed. It may happen that the valve stem does not project far enough through the rim to allow it to be screwed home. To remedy this a little pressure in a to and fro direction may be used on the tyre at the part in question, which will often be all that is required; but this failing, it will be necessary to deflate the tube and re-arrange it, as in this case the cause will be found in the valve stem being lob-sided in the rim, probably through the tube having become twisted.

How to Repair a Puncture.

To repair a tube, the following is the correct method for carrying out the work. If the puncture is not visible, inflate the tube until it is fully distended, but on no account over inflate it. Then, presuming the punctured place is still invisible, place the tube, section by section, in a dish, preferably a flat one, with sufficient water to immerse a small part of it at a time. By carefully going over it in this manner, bubbles will indicate the source of the trouble, which should then be marked. Dry the tube, and proceed to clean the punctured part with petrol; this has the effect of removing the sulphur which exudes from all tubes. Then treat in a similar way the prepared patch to cover the puncture, which should be of ample size according to the character of the spot it has to cover. Next rub with sand paper the surfaces of both, and proceed to spread over both the *thinnest* possible layer of solution. Then lay both patch and tube aside for at least fifteen to twenty minutes, when, if on touching both, the surface is found to be "tacky," it will indicate that the solution is not dry enough. When the parts are no longer tacky, take the patch, and apply it carefully, smoothing it so that it will be quite flat and free from creases. If it be possible to place the patched part between two *flat* surfaces or weights, it will make a better repair. It is advisable to use only properly selected and prepared patches, or rubber sheeting of the correct thickness. In the latter case, the edges will require careful tapering before using. Three-ply patches will also be found useful.

Even under the best conditions a roadside repair is apt to be uncertain, and, consequently, the motorist should always carry with him a spare tube to replace the punctured one, which should be repaired on reaching home. Both air-tube and patch should be treated as already described, but should be left for several hours for the solution to dry, and when the patch is applied the mended portion should be placed between two flat boards and then fixed between the jaws of a vice, so as to exert considerable pressure, and thus keep the patch pressed to the air tube. The tube should be left in this position for at least an hour.

How to Deal with a Burst Cover.

For this purpose a large sheet of prepared canvas should always be carried. A piece should be cut long enough to extend about 8 inches beyond the burst, and wide enough to considerably exceed the circumference of the tyre. This piece should be inserted between one edge of the cover and the rim. It should then be pulled over the air tube as it lies flat on the rim, and pulled out under the other edge of the cover. The ends should then be got under the cover, and the canvas manipulated until it rests closely and snugly inside the cover, and between it and the air tube, the edges of course extending beyond both beaded edges of the cover. The beaded edges should be replaced in the rim, with the edges of the canvas protruding at both sides, and the tyre should be inflated.

For the temporary repair of bursts, a gaiter or repair sleeve such as can be obtained from the leading tyre makers is most useful, and should always be carried.

To permanently repair a burst cover, it is necessary to use a vulcaniser, and the special material supplied for the purpose. Many garages are now fitted with a small plant—*e.g.*, the Harvey-Frost or the "G.B." of the Co. Chemical Co.—so that undue delay need not be incurred, as well also the owner having the assurance that the repair will be a permanent one. Our own experience of one of these apparatus has been quite satisfactory, and we found no difficulty in operating it, while the repairs, *if properly done*, are as satisfactory as if the tyre were sent to the makers. Needless to say, however, most makers prefer to repair their own tyres, and where a spare cover or two is available many users are in favour of entrusting the work to them.

As regards cuts and gashes in a cover a vulcaniser, such as we have already mentioned, is simply invaluable. With tyres the "stitch in time saves nine" maxim is particularly valuable. On the slightest suspicion of a swelling the cover should be removed and examined, and if there is any sign of the fabric giving way, a repair should be effected by means of the vulcaniser without waiting for the inevitable burst to take place. Gashes should be similarly repaired at once, if not they may gape still further, while in any case moisture will be admitted to the fabric and will rot it. Personally, we have found that a set of tyres, with one spare, will last from a year to eighteen months—a result attained altogether by careful and constant attention.

List of Spare Parts and Accessories to be Commended to De Dion Users.

1 pair petroleum lamps.
1 ditto. back light.
1 horn with gauze and flexible metal tube.
1 inlet valve complete.
1 exhaust valve ,,
2 inlet valve springs.
2 exhaust valve springs.
3 sparking plugs in case.
1 trembler.
1 contact screw.
1 pump driving spring.
1 amperemetre.
1 set of copper and asbestos washers.
1 packet of split pins
1 lifting jack.
1 pair combination pliers.
1 pair gas pliers.
1 large adjustable spanner.
1 small adjustable spanner.
1 carburetter jet key.
1 large screw driver.
1 small ,, ,,
square, round and flat files.
files, extra small, for sparking plugs and contacts.
1 hammer.
1 large funnel with gauze (for water).
1 large funnel with fine gauze (for petrol).
1 oil can.
1 tin of grease.
1 tin "D" oil.
medium emery, fine emery and rotten stone in wood boxes.
1 inner tube.
1 waterproof bag for carrying inner tube.
A few inches of rubber steam hose of a bore to suit the external diameter of the water circulation pipes.

Standard Types of De Dion Chassis, 1905-6.

The following are the present models made by De Dion-Bouton, Ltd. Further particulars as to same, and all enquiries as to cost of replacements, styles of coach bodies—English or French—may be obtained from the sole authorised British agents, De Dion-Bouton, Ltd., 10 Great Marlborough-street, Regent-street, London, W. It is essential to avoid delay when writing for spares or renewals to give the number of the car and engine. A full stock of all De Dion parts is kept at the London depot, and these may be obtained usually by return post. These facilities, however, exist solely for the benefit of the firm's own clients. Purchasers of De Dion cars from outside sources will not be supplied.

Models.	Cylinder Dimensions (Bore and Piston Stroke) and Engine Speed.	Gear.
6 h.p. single cylinder	90 mm. x 110 mm. (3 17-32 in. x 4 11-32 in.) 1,700 revs.	3 speeds forward and a reverse by expanding clutches.
8 h.p. single cylinder	100 mm. x 120 mm. (3 29-32 in. x 4 29-32 in.) 1,500 revs.	3 speeds forward and a reverse by expanding clutches.
9 h.p. single cylinder	110 mm. x 130 mm. (4 11-32 in. x 5 5-64 in.)	3 speeds forward and reverse by sliding gears and friction disc clutch.
12 h.p. double cylinder	100 mm. x 110 mm (3 29-32 in. x 4 11-32 in.) 1,500 revs.	ditto. ditto.
15 h.p. four cylinder	90 mm x 100 mm. (3 17-32 in. x 3 29-32 in.)	ditto. ditto.
24 h.p. four cylinder	104 mm. x 130 mm 4 1-16 in. x 5 5-64 in.)	

NOTE.—The 6 and 8 h.p. single cylinder cars are practically identical in detail, but the 8 h.p. model, besides having the larger engine, has a larger frame.

The chassis of the 9, 12 and 15 h.p. cars are made in two lengths The chassis of the 24 h p. is made in only one length With the exception of the 6 h.p. chassis, all the frames are in pressed steel, the exception being of the tubular type.

Expanding rear brakes are fitted to all models, excepting the 6 and 8 h.p. cars; on the latter they are of the band type.

De Dion-Bouton Lubricating Oil.

A new motor oil, scientifically selected and practically tested in the De Dion-Bouton laboratories and testing shops. This oil has been proved to give a considerable increase of power.

	Quarter Gallon.	Half Gallon.	One Gallon.	Four Gallons.
One can (not packed)	1/6	2/6	5/-	17/6
Cost of Packing—				
One can	2d.	3d.	5d.	8d.
Three cans ...	3d.	5d.	8d.	1/9
Six cans	4d.	8d.	1/-	Four cans 2/3
Twelve cans ...	6d.	1/-	1/9	

* * *

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